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OF

SCIENCE AND INDUSTRY.

Annual Record of Science and Industry for 1876. Prepared by SPENCER F. BAIRD, Assistant-Secretary of the Smithsonian Institution, with the Assistance of some of the most Eminent Men of Science in the United States. Large 12mo, Cloth, $2 00.

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PREFACE.

THE present volume of the "Annual Record of Science and Industry" constitutes the sixth of the series, and is intended to present an intelligible and popular account of the more important facts of progress in the various departments of the physical and natural sciences, and their applications to the conveniences and luxuries of mankind.

Its distinguishing features, as compared with other works intended to answer the same general purpose, are as follows:

First, a series of summaries of progress in the different branches of physical, natural, and industrial science, prepared by a number of the most eminent specialists in the United States, whose collaboration the editor has been so fortunate as to secure.

Second, a series of abstracts, more or less systematically arranged, of special papers, memoirs, or other publications, by various writers, and with references to the title, volume, and page of the source of information; these abstracts very rarely being transcripts from the original, but digests in which only the points of special novelty and interest are presented, with omission of irrelevant matter, and not unfrequently with critical remarks and elucidations. These have been for the most part edited and prepared by the specialists referred to.

Third, a list of the losses in scientific circles by death during the year.

Fourth, a list of the more important publications in science for the year embraced within the scope of the *Record*, with references to critical notices, serving as a guide to students and purchasers of books. In connection with this is a list of the principal serial works from which extracts or quotations are to be found in the volume.

Fifth, an extremely minute alphabetical index of authors and subjects.

Sixth, a systematic and analytical table of contents, by means of which reference can readily be made to whatever the volume contains, bearing upon any particular line of inquiry.

Seventh, in compliance with a generally expressed wish, the names of the authors of the different portions of the Scientific Summary are given for the first time in the present volume of the *Record*, in connection with their respective communications, all of them men occupying the front rank in America as authors and investigators. Other collaborators not contributors to the first division of the volume are Professor C. F. Himes, of Dickinson College, Carlisle, Pa.; Professor F. W. Clarke, of the University of Cincinnati; Professor E. D. Cope, of Philadelphia; Professor F. V. Hayden; Major J. W. Powell; Lieutenant George M. Wheeler, U. S. A., and several others who prefer to remain unmentioned.

It will be readily understood that the present volume is prepared for the general public, who desire to become acquainted with the more prominent steps of advancement during the year, without the trouble of resorting to the sources of original information concerning the same. Specialists may find little or nothing in it to merit their attention, and, indeed, they may naturally be inclined to criticise the work for not being more complete. It must be borne in mind, however, that the work is limited in extent, and that, in view of the enormous subdivision of labor at present in the line of scientific investigation, any attempt at exhaustiveness would involve a vast increase in the size of the book. At the present time there is scarcely a branch of science which is without one or more journals as its organs and an annual record devoted exclusively to its history; and to these reference should be made for more minute information. It is hoped, however, that but little of general or popular interest has been overlooked.

In the selection for the Scientific Bibliography the editor has been chiefly guided by the commendatory notices which have appeared in the more prominent scientific journals of the day, and references to the pages of the journals wherein the works catalogued and reviewed are given. As the journals in question are generally easily accessible, the reader is thus furnished with a trustworthy guide in his selection of books.

SPENCER F. BAIRD.

SMITHSONIAN INSTITUTION, WASHINGTON, *March* 1, 1877.

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GENERAL SUMMARY

OF

SCIENTIFIC AND INDUSTRIAL PROGRESS

DURING THE YEAR 1876.

ASTRONOMY.

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INTRODUCTION.

IN presenting a review of the progress of Astronomy during the past year, it is to be remembered that the principal results reached are such as can be readily classified under appropriate heads, and there are but few in this year, as in every year, which call for especial and peculiar mention. The successful application of photography to the registration of star spectra by Huggins and Draper, however, constitutes a most important step in the progress of stellar physics. Many publications of standard value have been made, such as the "Observations of the Zodiacal Light," by Heis; the "General Catalogue of Double Stars," by Burnham; the zones of nebulæ observed by Vogel at Leipzig; Langley's and Spoerer's solar investigations, and many others. A most striking advance is the growing tendency of astronomers to an economical division of labor, as, for example, in the prosecution of the zones of the German Astronomical Society; in the computation of comet orbits under the auspices of the same society, etc. A praiseworthy example of co-operation is shown by the Italian observatories, which have divided the field of work according to plans originally devised by Tacchini. By a loyal and zealous co-operation, the whole energy of the astronomers of Italy is judiciously applied to the subjects of work in hand, so that each observatory has its especial field, and contributes its full share to the general progress.

The true progress of observational astronomy is to be forwarded by the faithful carrying out of well-devised plans. The number of such concerted and systematically carried-out schemes of observation is now very great, and extends to all branches of the subject, from the spectroscopic observations of solar phenomena to the meridian observations of asteroids at Greenwich and Paris, and similar work elsewhere. While the present instruments are utilized, new observatories are being founded; and, in particular, many large telescopes are building or newly completed. The history of astronomy has been well exemplified in the interesting Loan Collection at South Kensington; and the republication of the works of Bessel and others is of more than passing importance, and it is to be hoped that these may lead to a collection of the works of the elder Herschel, which is so much needed. Discoveries of new minor planets have ceased to be the novelty they were in 1801, owing to the assiduity of astronomers. The intra-Mercurial planet has so far not been detected, although patiently sought for. With this brief preface, we may proceed to a systematic though condensed view of the work of the present year.

NEW OBSERVATORIES FOUNDED, ETC.

The new *Astrophysikalischen Institut* of Potsdam, under the charge of Spörer, is still in process of building, as well as the Physical Observatory at Paris, under Janssen. Mouchez has established a school of Practical Astronomy and an observatory at Montsouris. The new National Observatory of Austro-Hungary at Vienna, an institution of the first class, is to be completed in 1877. The Savilian Observatory for Celestial Physics at Oxford has also commenced its operations. An observatory for spectroscopic observations of the sun has been founded at Calcutta. The Observatory of Lisbon is to undertake photographic researches.

Little has been done toward the carrying out of the provisions of Mr. Lick's trust for the erection of an astronomical observatory in California. It is to be hoped that this valuable gift to Astronomy will soon begin to yield results. The observatory at Glasgow, Missouri, is completed and partially equipped, and has begun work by a series of observations on Saturn's satellites. One of the most important steps of the year has been in the division of labor adopted among the Italian observatories.

The Royal Observatory at Greenwich has seriously entered into a new field, that of celestial physics. Spectroscopic and photographic work is constantly done. The observatory at Melbourne has received considerable accessions to its instrumental outfit, and is making important contributions to the astronomy of the southern hemisphere in several fields.

The National Observatory at Paris has mounted its four-foot reflector during the year. The mounting is said to be satisfactory, but the mirror is not yet in perfect condition, and the glass for a new one has been ordered. The Foucault reflector of thirty-one inches aperture has been mounted at Toulouse since February, and Tisserand has begun a study of the Orion nebula and of the fainter satellite systems. The instruments for the Strasburg Observatory are well-nigh completed, and we may look for important work on comets and nebulæ from its accomplished director. Its outfit will be most complete, no pains having been spared in the design and in the execution of the various instruments. Dr. Valentiner, of Leyden, is transferred to Mannheim *vice* Schönfeld, who succeeds Argelander at Bonn. Krüger, of Helsingfors, has succeeded Hansen at Gotha.

Stone, of Washington, has been appointed to be Director of the Cincinnati Observatory, and the Dudley Observatory of Albany is now opened under the charge of Mr. Lewis Boss. Professor Pickering, formerly of the Massachusetts Institute of Technology, has been appointed to be Director of the Observatory of Harvard College. The Observatory of Cordova has completed its zone observations, and is proceeding with the publication of its uranometry.

THE SUN.

Powalky has published an important paper on the Dorpat observations of the sun, 1823–1839.

The solar protuberances are daily mapped by Tacchini, of Palermo, and Secchi at Rome; at Greenwich, by Christie and Maunder; and by various other observers.

Daily photographs are taken at Greenwich, at Paris (by Cornu at the observatory, and by Janssen), Moscow, Toulouse, Kasan, etc.; also by Lockyer, at South Kensington, with a Huyghens lens of 123 feet focus. The spots are observed daily at Madrid, Oxford, Berlin, Zurich, etc. Melbourne also takes daily photographs.

The Royal Astronomical Society has recently acquired an eleven-year series of sun-photographs made by Professor Selwyn.

Secchi has recently brought out a second and greatly enlarged edition of his treatise on the sun. The journal of the Spectroscopic Society of Italy continues its *résumés* of spectroscopic and other work; and its pages may be consulted for special memoirs on spectroscopy. Lockyer, Abney, Roscoe, Stewart, and Vogel are still occupied with their normal map of the solar spectrum; and Draper is pursuing his investigation of metallic spectra. The third volume of the Bothkamp observations, by Dr. O. Löhse, is devoted almost entirely to the discussion of his own solar observations.

Young has recently taken up an important research on the rotation of the solar surface as derived from spectroscopic observations. His observations give for the velocity of the sun's rotation 1.42 miles per second, while direct observation gives 1.25 miles. Vogel's earlier results gave from 1.62 to 1.94 miles. The difference between Young's result and that given by direct observation is supposed by him to have a possible physical interpretation, viz., that the solar atmosphere really sweeps forward over the underlying surface. The results obtained by Christie at Greenwich are not yet printed, although they have been presented to the Royal Astronomical Society.

The simple arrangement proposed by Hastings some years ago for a comparison of the two limbs of the sun has not, we believe, been applied to this research, for which it seems to be peculiarly fitted.

Langley has continued his observations of solar phenomena, particularly with reference to the heat of various portions of the sun, of sun-spots, etc., and of the effect of sun-spots on terrestrial temperature. In a recent experiment, the light of the sun was compared with that of the molten iron of a Bessemer converter, and the conclusion reached that the temperature of the sun is really far above any temperature observable on the earth, being probably expressed by millions of degrees.

SOLAR ECLIPSES.

Vol. XLII. of the *Memoirs of the Royal Astronomical Society* contains Tennant's report on the total eclipse of 1871, December 11, and Stone's on that of 1874, April 16. Stone's is particularly noticeable, as he has clearly proved the outer corona to be a solar appendage. In this connection Young's discovery of the duplicity of 1474 K is noteworthy, as well as the admirable device by which the discovery was made.

Vol. XLI. of the *Memoirs of the Royal Astronomical Society* contains a discussion, by Ranyard, of the phenomena of recent solar eclipses, which is intended to be exhaustive.

A very interesting daguerreotype of the solar eclipse of 1851, taken at Königsberg, is shown at the Loan Collection at South Kensington. It is, we believe, the first photographic image of the corona, and has been little known until its exhibition at London.

The transit of Venus reductions are not yet completed on the part of any country. Attempts to observe the velocity of light experimentally (and hence the distance of the sun) are to be made by Newcomb, of Washington, in concert with Barker, of Philadelphia, and by Forbes, of Edinburgh.

Lindsay and Gill will shortly publish their value of the solar parallax from observations of Juno. The method has been perfectly successful.

THE MOON.

In the Lunar Theory, Airy continues his researches at Greenwich, as does likewise Newcomb at Washington. Stockwell is occupied with the development of his new views on the theory. Schjellerup has also given the subject some attention, his only published work being, however, a reply to Stockwell's pamphlet. A new lunar inequality has been detected by Newcomb.

Lohrmann's map of the moon is now to be completely published under the editorship of Schmidt, who is also publishing his own great chart. Tempel is likewise engaged on a map of the moon.

Neison has embodied his work on the moon's atmosphere, physical features, etc., into an octavo book lately published.

Work on the British Association chart of the moon (Birt's) is, we believe, temporarily suspended for want of funds.

It is understood that the attraction-meter devised by Dr. C. W. Siemens, and exhibited by him at South Kensington, is soon to be applied by Sir William Thompson to determine the mass of the moon.

THE PLANETS AND SATELLITES.

Drawings of Mars continue to be made by Terby and others. Trouvelot, of Cambridge, has made one hundred and twenty-five drawings of Jupiter during the present opposition—a very important work, as the planet was too low for observation in Europe. Trouvelot confirms the statement of Löhse that changes of unusual magnitude are this year occurring on Jupiter. He also has published a drawing of Saturn, with a discussion of its physical features, in which some new views of the shape of the rings are advocated. Weber's supposed observation of Vulcan, on April 4th, 1876, has led, by request of Le Verrier, to a general examination of the sun, on October 2d and 3d, and 9th and 10th, with the object of detecting this planet in transit. This search was unsuccessful.

Janssen has devised an apparatus by means of which a photograph of the sun may be automatically taken every quarter of an hour, and this he proposes to erect at Paris, for the purpose of detecting interior planets in transit. The whole question of the existence of a planet interior to Mercury (Vulcan) has been carefully examined in a series of memoirs by Le Verrier, abstracts of which are given in the following pages. His general conclusion is that in 1885 a transit of Vulcan will take place, and to that time he defers the definite answer to the question of Vulcan's existence.

It has been pointed out, however, that in 1878 a very favorable total solar eclipse occurs in America, and with proper care such a body as Vulcan is supposed to be can hardly escape detection if especial attention is directed to it.

Following is a list of the minor planets discovered during the year:

MINOR PLANETS.

Number.	Name.	Date of Discovery.	Approximate Magnitude.	Discoverer.	Observatory.
		1876.			
158	Koronia,	Jan. 4,	11.12	Knorre,	Berlin.
159	Emelia,	Jan. 26,	12.5	Paul Henry,	Paris.
160	Una,	Feb. 25,	11	C. H. F. Peters,	Clinton.
161	Alhor,	April 19,	11	Watson,	Ann Arbor.
162	?	April 22,	12	Prosper Henry,	Paris.
163	Erigone,	April 28,	12	Perrotin,	Toulouse.
164	Eva	July 12,	12.5	Paul Henry,	Paris.
165	Loreley,	Aug. 9,	10.7	C. H. F. Peters,	Clinton.
166	Rhodope,	Aug. 10,	11.2	C. H. F. Peters,	Clinton.
167	Urda,	Aug. 28,	12	C. H. F. Peters,	Clinton.
168	Sybilla,	Sept. 28,	11	Watson,	Ann Arbor.
169	Zelia	Sept. 28,	11	Prosper Henry,	Paris.

Palisa, of Pola, has likewise rediscovered *Maia* (66), which has been lost for some time.

Le Verrier has published, or shortly will publish, tables of Jupiter, Saturn, Uranus, and Neptune. Other occupations have hindered Mr. George W. Hill in the preparation of his tables of Saturn.

The theory of the satellites of Jupiter has been investigated by Souillart, who is preparing tables of their motion. Todd, of Washington, has extended the tables of Jupiter's satellites to 1900, and the American ephemeris will publish the tables. Newcomb has published tables of the motion of the satellites of Uranus and Neptune. A great number of observations of the satellites of Saturn has been made by Hall at Washington, and at Greenwich, and Glasgow, Missouri, observations have been made, aided by the valuable ephemeris of Marth. The Washington observers have also made a number of observations of the satellites of Uranus and Neptune. Hall has discovered a white spot on Saturn which has been followed through over sixty revolutions, and the observations of which give a rotation time of $10^h\ 14^m\ 23.8^s \pm 2.3^s$. The Observatory of Leyden has become possessed of Schroeter's unpublished work on Mars.

COMETS.

There has been no discovery of a comet during the year.

Bredichin, of Moscow, has published an important memoir on the phenomena of the tail of Comet III., 1862. Kowalczyk, of Warsaw, has published a definitive orbit of Comet II., 1840. It is an ellipse of about 3700 years' period. Weiss, of Vienna, in investigating the orbit of the comet of Coggia (November, 1873), concludes it to have a period of 6.20 years, and to be identical with that of Pons (1818). Tuttle's periodic comet will reappear in 1884, and the preparation of an ephemeris, and a discussion of its elements, is under the charge of Professor O. Stone, of the Cincinnati Observatory.

MOTIONS OF STARS TOWARD OR FROM THE EARTH.

The theoretical basis upon which rest the recent determinations of the motions of stars in the line of sight, by means of the spectroscope, has been called in question by Van der Willigen, in a mathematical memoir published some years ago. During the past year Secchi has undertaken to repeat certain measures of Huggins upon several of the brighter stars, and he has found that in his own observations constant errors arose, which masked the true deviations of the stellar lines from their corresponding lines in the comparison spectra. On examining the results obtained by himself, Huggins, Christie, and Vogel, he came to the conclusion that these showed a strong probability that the determinations were affected with constant errors. This was particularly so in the case of Greenwich, nearly all of the results obtained at this observatory showing a motion of the star *toward* the earth. Since the publication of this paper, Christie, of Greenwich, has published a new set of measures, which, in the main, corroborate Huggins's previous determinations; and Huggins has replied to some strictures by Secchi in a note which describes the delicacy of the research, and states that the difficulties Secchi encountered must be overcome before any trustworthy results are possible, and that Huggins himself had successfully avoided these drawbacks. Since the above paragraph was in type, Huggins has communicated to the Royal Society, and Draper to *Silliman's Journal*, accounts of the successful application of photography to the registration of stellar spectra.

SOLAR MOTION IN SPACE.

Safford has recently taken up anew the investigation of this question, using for the purpose Argelander's 250 stars.

In studying these stars, Professor Safford grouped them by tens, assuming those to be equally distant whose proper motions in arc were nearly equal, and therefore leaving entirely out of consideration the brightness of the stars. His first result, as regards the direction of the movement of the solar system, was not very different from those of his predecessors; but there appeared indications that, for each of his groups of stars, the average proper motion was inversely proportional to the average distance; in other words, that our assumption of stellar distances ought to depend upon proper motions. He concludes that the stars having similar motions especially need study at this time, and that eventually we may hope to use the solar motion as a sort of base to advance our knowledge of stellar distances.

NEBULÆ.

Winnecke, of Strasburg, has begun work again in this field with powerful instruments. Bruhns has begun the publication of charts of nebulæ observed in zones at Leipzig. Vogel has published the results of a determination of the positions of all the nebulæ in the Leipzig zone of the new *Durchmusterung*. It takes its place at once with the works of Auwers, Schönfeld, and Schultz, and Vogel's former work of 1867, as an acknowledged classic. Vogel has also made some drawings of hitherto unpublished nebulæ. Forty or fifty southern nebulæ, formerly figured by Herschel, have been drawn and studied by Ellery, of Melbourne, and his assistants, and the results will shortly be published. Gould, of Cordoba, has made many photographs of southern clusters and double stars. A monograph of the ring nebula of Lyra has been published by Holden, of Washington, as well as a detailed discussion of all published drawings and observations of the nebula G. C. 4403, in which it is endeavored to show a veritable proper motion to this body. Tisserand, of Toulouse, and Tempel, of Florence, as well as Holden at Washington and Trouvelot at Cambridge, have published preliminary results of their work on the Orion nebula. Bredichin, of Moscow, has investigated the spectra of many planetary nebulæ, and finds them in general to be of one type, and usually to be sensibly the same. Dreyer, of Parsonstown, is preparing a supplement to Herschel's general catalogue.

DOUBLE STARS.

Double stars have been faithfully observed during the past year, the most noteworthy publications of private observers being those of Dembowski, Gledhill and Crossley, Wilson and Seabroke, and Barclay.

Otto Struve at Pulkova, Dembowski at Gallarate, Dunér at Lund, Newcomb and Hall at Washington, Wilson and Seabroke, of Rugby, Crossley and Gledhill, of Halifax, and others, have published important measures of difficult stars. Burnham, of Chicago, and Howe, of Cincinnati, have published lists of new double stars. A method for obtaining the relative personal equation of various double-star observers by simultaneous observations of a selected list of doubles is proposed by Struve, and will be followed by several observers.

The double-star observations and discoveries of O. M. Mitchel have been prepared for the press by the present Director of the Cincinnati Observatory, Professor Ormond Stone, and will shortly be issued.

The supposed discovery of a companion of Procyon in 1873, and the subsequent observations of 1874 by Otto Struve, are now supposed by him to have been deceptions. The companion demanded by Auwers' theory has thus far not been detected.

BINARY STARS.

Doberck, of Markree, has taken up the subject of the computation of binary star orbits with much zeal, and to him we owe many publications on this subject. Tisserand, Schiaparelli, and others have contributed to this subject important papers.

A work by Crossley, Wilson, Gledhill, and Doberck, jointly, is in course of preparation on the general subject of double and binary stars, their observation, history, orbits, etc. Lord Lindsay has prepared for publication an index to W. Struve's double-star observations. Of particular binaries, one of the most noteworthy is *Beta Leporis*, discovered by Burnham (distance about three seconds of arc), which has a motion of about 2° a month in position angle. This indicates this star as probably one of the nearer stars, and makes an investigation of its parallax desirable by some southern observatory.

ZODIACAL LIGHT, METEORITES, VARIABLE STARS, ETC.

The observations of J. C. Houzeau, of the Observatory of Brussels, and his conclusions therefrom, constitute a contribution of high importance to the knowledge of the zodiacal light. Heis has published the results of his observations of the zodiacal light from 1847 to 1875; and Serpieri is discussing carefully the observations of Chaplain Jones, U. S. N. Mr. Henry C. Lewis, of Germantown, has made an extended series of zodiacal light observations. Wright, of New Haven, has investigated the spectrum of the zodiacal light, and also the chemical constitution of meteorites. This last research tends to establish more fully the relation between comets and meteor-swarms.

The variable stars continue to be observed by Schönfeld, Schmidt, and others; and Schmidt has published during the year many important memoirs on this subject. Schönfeld's second catalogue (Mannheim, 1876), with its copious notes, is of capital importance in this subject. Schmidt has detected a *new* (temporary) star in *Cygnus*, which, for a few days, was of the third magnitude.

CATALOGUES OF STARS.

Among others we note the Coast Survey List of Latitude Stars, 2164 in number. Moesta, of Chili, publishes a second volume of Santiago observations, with an important comparison of his work with that of the earlier observers. Stone's catalogue of southern stars has been printed during the year. The Harvard College catalogue of 373 fundamental stars is noticed elsewhere. Gould, of Cordoba, has a catalogue of 12,000 southern stars. The third Radcliffe catalogue of 4000 stars is preparing. The Observatory of Brussels is preparing a catalogue of 12,000 stars. Safford has prepared a new catalogue of Standard Declinations for the Engineer Department.

Burnham's catalogue of (about) 10,000 double stars has long been ready for the press; but is temporarily delayed, and will be printed in 1877.

Boss, of Albany, is preparing for the U. S. Northern Boundary Commission a catalogue of 490 stars, which will give standard positions. All trustworthy observations of each star (including Bradley's) have been used and rigorously discussed.

Stone, of Cincinnati, publishes a catalogue of 50 new double stars.

Schönfeld's second catalogue of 143 variable stars has appeared during the year.

MISCELLANEOUS.

We note the establishment during the year of Königsberger's *Repertorium der Reinen und Angewandten Mathematik*, under the editorship of Dr. Leo Königsberger and Dr. Gustav Zeuner, of Dresden. This periodical will have the novel feature of abstracts of works on Astronomy, Geodesy, Mathematical Physics, etc., by the authors of the works themselves. The *Analyst* of Professor Hendricks, at present our only mathematical journal, continues to maintain its position.

It is understood that a mathematical journal is proposed to be published by the Johns-Hopkins University, under the experienced editorship of Professor J. J. Sylvester.

The publication of a selection of the works of Bessel, by Dr. Engelmann, of Leipzig, deserves a special mention. A similar compilation for the works of the elder Herschel is much to be desired.

The opening of the Loan Collection of Scientific Apparatus at London has been an event of great importance during the year. The special features are described in detail in another place. The astronomical instruments of the Centennial Exposition were mostly of the ordinary constructions, and, although exhibiting well the present practice of field astronomy and geodesy, presented few novel features. A good exhibition of optical glass was made by Feil, of Paris, and Chauce, of Birmingham. The calculating-engine of Mr. George Grant, of Boston, and some special optical apparatus and material, were particularly noteworthy.

A series of astronomical drawings exhibited by Trouvelot, of Cambridge, was especially interesting, on account of the great facilities at the artist's command for viewing the objects represented, most of them having been examined with the Harvard College refractor (15 inches).

The progress of the zone observations undertaken by the German Astronomical Society, one of the most important works of the decade, will be found described in another place.

METEOROLOGY AND TERRESTRIAL PHYSICS.

By CLEVELAND ABBE.

METEOROLOGY.

The most interesting feature in the progress of meteorology during the year has been the increasing attention paid to the deductive study of atmospheric movements, as evidenced by the works of Blanford, Ley, Hann, Mohn, and Goldberg, all of whom have contributed to a clearer knowledge of the *rationale* of the winds and currents of the air. In climatology we have to record the publication by the Smithsonian Institution of the temperature tables and the winds of the globe. New data have also been published from regions hitherto but little known—such as the volume of meteorological observations in the Amoor Valley, edited by Von Schrenck, for the St. Petersburg Academy of Sciences; the monthly barometric and other means for stations in the Argentine Confederacy, published by Dr. Gould; the two volumes of details of observations published by the Canadian government.

Of daily weather maps, those published by the Danish and the United States Weather Bureaus have the widest circulation; the former has been extended so as to form a continuation of the United States maps. The daily bulletin of simultaneous observations, taken throughout the world at 7.35 A.M., Washington time, has been maintained by the Army Signal Service; and the specimen maps published of a weather chart, embracing the entire northern hemisphere, show that when published for every day, these will mark a new epoch in meteorology.

We have in the following summary briefly noticed some of the meteorological events of the year and the publications that have been received, arranging the notes, as far as possible, in the following order, viz.:

A. Meteorological Societies, Institutions, and Individuals.
B. " Instruments and Methods.
C. " Investigations and Results.

A. INSTITUTIONS AND PERSONS.

At the Geographical Congress at Paris a letter of merit, being the highest award there recognized, was presented to the United States Army Signal Service for the perfection of its organization and the usefulness of its works.

In the annual review of meteorological work at present in progress in England, the *Quarterly Journal* of the Meteorological Society states that the marine meteorology of the equatorial regions of the Atlantic Ocean, as compiled at the Meteorological Office in London, may be expected to be published during the year, and that upon the completion of this work the office will proceed to the study of the meteorology of the neighborhood of the Cape of Good Hope. The office continues also the collection of data relative to the weather of the North Atlantic Ocean during August, 1873, in which month, it will be remembered, the great hurricane occurred in Nova Scotia. For this purpose some 280 logs of vessels have already been received.

The office has also undertaken the investigation of atmospherical conditions at high altitudes, and has therefore established a station at Settle, in Yorkshire, England.

The Scottish Meteorological Society have set on foot an inquiry into the causes of the earliness or lateness of salmon, by means of observations made with thermometers continually immersed in the rivers and in the sea adjoining their mouths, and by gauging the water of the rivers.

The Scotch Herring Fishery Board have also continued their investigations into the connection between meteorology and the success of the fisheries. Similar observations have been continued in America by the co-operation of the Fish Commissioners and the Army Signal Office.

The continuous photographic records of the barometer obtained at the Greenwich Observatory for nineteen years (1854 to 1873) are being studied, by Professor Airy, with reference to the possible existence of any measurable lunar atmospheric tide.

At Edinburgh Professor Smyth repeats the expression of his confidence in the possibility of recognizing particular sets of lines or bands in the spectrum of daylight, which bands acquire a marked prominence whenever the atmosphere is charged with watery vapor at high temperature, or whenever rain is imminent from the southeast.

Dr. Köppen, of St. Petersburg, has, it is stated, accepted the directorship of the German Seewarte, at Hamburg, whose object it is to study meteorology on a large scale, embracing the movements of the whole atmosphere of the globe, for which work his published memoirs prove him to have a peculiar adaptation.

The annual volumes for 1874 and 1875, published by Professor Kingston, of Toronto, show the great attention paid to the subject of meteorology in the Dominion, and the energy with which the system is being extended. The tri-daily simultaneous observations of temperature, pressure, and wind are published in full for fourteen stations, and monthly means are given for numerous others.

At Vienna the annual volume of observations in Austria for 1874 has appeared with customary regularity. The tri-daily observations are published in full for ten stations of the first class. Monthly and annual means are given for over a hundred stations of the second and third classes, followed by a general review of the temperature and rainfall and by the average temperature of each pentade of the year, according to Dove's system, for about a hundred and twenty stations. The magnetic observations made at Vienna are also given in full. The phænologic observations are a very prominent feature in the Austrian and Belgian climatological reports, and are given in full for thirty-three stations and for over one hundred plants in the present volume.

The results of observations on the fisheries made on the German coast, and their connection with the physical peculiarities of the North Sea and the Baltic, have been published at Kiel in monthly parts, which give, first, physical observations made at ten stations on the Baltic and seven on the North Sea coasts; second, meteorological observations made at Kiel, Lubeck, Westerland, and Helgoland; and, third, fishery statistics for seven stations on the Baltic and one on the North Sea. The physical observations include determinations of the temperature of the water at the surface and at considerable depths below; the height of the water at morning, noon, and evening; its specific gravity at and below the surface, and the direction and velocity of the current. The fishery statistics give the total catch of the five more important kinds of fishes, namely, herring, sprat, haddock, flounder, and salmon; and also the details of the methods employed in fishing for each.

The *Annalen* for 1874 of the Central Physical Observatory at St. Petersburg was published in February, 1876, a degree of promptness equaled only by the punctuality of the publications at Greenwich; but far more surprising when we consider that the 600 pages of the present volume relate, not to work done at single stations, but at ninety stations scattered over the Russian domains. Such a result is certainly a high tribute to the excellence of the system and energy which Professor Wild has infused into the great Russian establishment. A very complete statement is given of the peculiarities of each station, and the observations, which are published in full, as in former years, are accompanied by a monthly and annual *résumé* arranged very nearly according to the form of publication recommended by the Vienna Congress, an accordance which will be more perfectly attained in the succeeding volumes. The hope has been earnestly expressed on all sides that the French, British, and American meteorological offices will ere long take steps to insure a similar conformity in their climatological publications.

One of the most valuable contributions to meteorological literature is the *Repertorium fur Meteorologie*, published by the St. Petersburg Academy of Sciences, under the editorship of Professor Wild, and which has now reached its fifth volume. Professor Wild announces that the Central Physical Observatory at St. Petersburg has received from the Grand Duke Constantine an eligible piece of land in the imperial park near the city, at Pavlosk, and the necessary appropriation of money for the erection of an auxiliary meteorological observatory.

The Imperial Meteorological Observatory at Tokio, Japan, has, under the direction of the government surveyor, Mr. McVean, continued its observations, and has published five day means and reports in the Yokohama papers.

In addition to the labors of Mr. McVean at Yokohama, it is understood that the Japanese government has taken some steps toward the establishment of more extensive meteorologic studies. On the one hand the Kai-ta-ku-shi, or the department for the colonization and development of Jesso, determined, in 1874, to establish eight stations on that island, and intrusted the organization of the whole system to Professor G. J. Rockwell; and, on the other hand, the general government is looking to the organization of a system of observation, and, as far as possible, of telegraphic reports, throughout Niphon and the lesser islands, under the general supervision of the department of education.

Professor Foster, of Berne, Switzerland, in presenting the report of observations for 1873 and 1874, states that a special meteorological observatory is now being erected in Berne, which will attend especially to the relations of the atmosphere, to agriculture, forestry, and hygiene.

The Italian Meteorological Commission has made an elaborate investigation and report, in which certain regulations are recommended which will secure almost perfect uniformity among the Italian observers.

The phenomena of the upper strata of the atmosphere are annually receiving increased attention, especially in France and America; in the former country not only frequent balloon voyages, but three permanent mountain stations contribute to our knowledge of the subject; in the latter country, Mr. A. S. King, the aeronaut of Boston, has continued to make numerous voyages, of which he keeps careful record, and much is anticipated from observations to be made by him, at Philadelphia, in a captive balloon. The publication of De Fonvielle's *Aventures Aeriennes* is an important contribution to this subject.

A report of the British Royal Science Committee will, it is said, probably result in soon terminating the anomalous and embarrassing position that the London Meteorological Office has long occupied in reference to the government.

Professor Hinrichs has continued to collate and publish the rainfall reports from numerous stations in Iowa. Predictions are also made by him as to the probable weather for the coming month.

An office for the study of maritime meteorology has been opened at the "Dépôt des Cartes et Plans" in Paris, under the superintendence of M. C. Ploix.

Gautier, of Geneva, has taken especial pains to secure meteorological observations in Labrador from the Moravian missionaries, and has published those made between 1867 and 1874. Besides these, there exist also some records due to Lamont, of observations about 1841. The original record of observations made by the first missionaries in Labrador, from 1776 to 1784, seems to have been accidentally lost to science, until, in 1873, it fell into the hands of the author, who is engaged in preparing them for publication.

The Permanent Committee of the Vienna Meteorological Congress held its third annual session at Utrecht, in June, 1876; it was reported that almost perfect uniformity had been attained in the publication of climatological statistics for purposes of international exchange. With reference to barometric gradients, it was resolved that they should be expressed either on the English scale of tenths of an inch per English mile, or on the metric scale of millimeters per degree (69½ statute miles). The next meeting of the Permanent Committee will be held at Rome, September, 1877, on the occasion of the reassembling of the General Congress.

The Observatory at Melbourne has published three fine volumes of meteorological observations made in 1872, 1873, and 1874 throughout the colony of Victoria. Mr. Ellery states that he has already joined in the American system of simultaneous observations, which is now of world-wide extent.

The Director of the Geological Survey of Brazil, Professor C. F. Hartt, writes that he hopes to be able to secure a proper attention to meteorology in that important empire.

The Observatory at Batavia, under Dr. Bergsma, has published in a large quarto volume the hourly observations made from 1866 to 1870.

B. INSTRUMENTS AND METHODS.

The most important event in matters relating to instrumental meteorology has been the exhibition of the Scientific Loan Collection at the South Kensington Museum, where an almost exhaustive array of every conceivable form of apparatus for meteorological research was presented for the inspection of visitors; in connection with these an admirable catalogue and a hand-book were published by the Royal Science Commission. In the latter volume, dissertations were contained by eminent specialists, that on meteorology by R. H. Scott. In the same connection a series of scientific conferences was held; that on meteorology occupied three days, ending June 2d.

The Centennial Exposition at Philadelphia has also been of considerable importance to American meteorologists. There was exhibited there, in active operation, the very beautiful and efficient printing meteorograph, invented by Theorell, of Sweden, as also one by Baumhauer, of Haarlem.

Apparatus by the best European and American makers was also exhibited; especially noticeable was the complete display by the Army Signal Office of its own methods and instruments.

The general rules for observers as recommended by the Vienna Congress of 1873 have been very widely accepted by national systems of meteorological observation, as shown by the annual reports of Wild at St. Petersburg and Scott at London; and especially in the uniformity introduced into the publications of the climatological observations at Vienna, Christiania, Copenhagen, London, St. Petersburg, and Constantinople.

The aneroid barometer has received great attention of late years, and bids fair to rival the ordinary mercurial barometer for most purposes. The best instruments appear to be those made by Naudet & Co., of Paris, and Goldschmid, of Zurich, both of which embody improvements that appear not yet to have been adopted by other makers.

The ordinary aneroids have been made the subject of a rather careful investigation by Grassi, of Pavia, who has considered especially their adaptation to hypsometric work. In the course of his memoir he brings to light the hypsometric formula of St. Robert, which seems to be but little known outside of Italy, but which gives quite as good results as Ruhlmann's.

Professor Schreiber, of Leipsic, has also paid much attention to the reliability of the aneroid barometer, and maintains that with proper care the instruments of Goldschmid, Hipp, and Naudet are probably equal in reliability to mercurial barometers, provided only that a proper degree of care be taken in their use. Both kinds of instruments are, he maintains, essentially relative, rather than absolute, in their indications; both are liable to serious accidental errors and changes, and both require to be transported with the same tenderness. He especially criticises the too common habit of reading the aneroid as it hangs vertically, and maintains that it should be kept with its face horizontal, quite as carefully as a marine chronometer which is hung in its gimbals.

Staff-Engineer George, of the British Navy, proposes to refill a mercurial barometer, when used in traveling, at every station occupied by the observer, and to empty it before packing it away for transportation. He removes any bubbles of air that might be likely to remain in the tube, not by boiling the mercury, which is both tedious and dangerous, but by mechanical means, viz., the introduction simply of a wire, to the end of which a feather is attached, the repeated twirling of which within the tube agitates the mercury and dislocates any bubbles of air.

Professor Kedzie, of Lansing, Michigan, has made a series of ozone observations, which are published by the State Agricultural College. He recommends that such observations be continued, and gives the necessary directions. The subject is one which observers will not consider to have been satisfactorily settled even by the adverse decision of the Vienna Congress and eminent specialists.

Mr. Scott, of London, communicates to the Meteorological Society some observations, showing that, on the average, the French "Thermomètre Fronde," or whirling thermometer, is not a very decided improvement upon the ordinary fixed thermometer, when the latter is properly sheltered from radiations.

Marié Davy has published, in the *Bulletin* of the Observatory of Montsouris, full details of all the special apparatus employed there to study the physics of the atmosphere, by which is especially meant the study of the part played by aqueous vapor, both visible and invisible.

Bosanquet publishes two papers on the "Polarization of the Light of the Sky." This obscure subject received, in 1865, a new interest from Tyndall's observations on the delicate blue colors and polarized light of finely divided vapor. Bosanquet has now for the first time shown the full bearing of these observations upon the subject of atmospheric polarization. He shows that the diminution of the maximum polarization from zenith to horizon may be regarded as due to a small increase in the mean size of the particles. Except in so far as modified by this circumstance, the phenomena observed in the sky should be arranged symmetrically about an axis drawn toward the sun, and the neutral points of Brewster and Babinet become merely special points in a neutral circle about the sun, while the neutral point of Arago belongs to a similar circle about the antesolar point. Within these small circles the polarization is negative, except at their centres, which ought theoretically to be the only neutral points in the sky. It is hoped that these difficult but valuable observations will receive the attention they deserve on account of their bearing upon the moisture of the air. Bosanquet has in a second memoir, published in the *Philosophical Magazine*, given a method of constructing a polarimeter especially adapted to these delicate observations.

Great interest has been excited by the ingenious radiometer invented by Mr. Crookes. Some meteorologists in Europe have, we believe, undertaken regular observations with the instrument, in hopes of obtaining thereby a measure of the total radiation of the sun. In this, however, we presume they are doomed to disappointment, since it seems to have been abundantly demonstrated that the rotation of the disks is due to only a small portion of the solar radiation, being merely a consequence of their heating effect. It may, however, be that the instrument, in a modified form, can be used as an additional means of investigating the important question of the absorption of the sun's heat by the atmosphere. Among those who have published investigations on the radiometer may be mentioned Poggendorff, Carrington, Reynolds, Stoney, Dewar, and Tait, all of whom maintain that the kinematic theory of heat fully explains its motions.

The subject of solar radiation has been officially taken up by the Meteorological Society of England, which undertakes to carry on the work begun by the Rev. F. W. Stowe; the society will, however, adopt the comparison of the black with the bright bulb thermometer, both in vacuo, instead of comparing the black in vacuo with the maximum temperature of the air as recorded in the shade.

In connection with this discussion a new series of observations has been begun, and eleven stations have undertaken observations on the new plan, from which interesting results must be expected. Among these stations is the observatory at Kew, at which the registering sun-dial invented by Mr. Campbell is now in action, it having been already in operation for several years at Whitehall. This instrument consists of a glass sphere set in a wooden bowl; and the effect of the sun is measured by the amount of wood charred by the sun's action in the course of six months.

Mr. Roscoe appeals to the meteorological observatories of the world to carry on some systematic observations upon the varying chemical intensity of the direct and diffused solar light. The improved apparatus devised by him is, he states, as simple as could be wished; he has made most minute investigations into its errors, and will undertake the determination of the relative corrections with respect to the apparatus belonging to other observers, if so desired.

An elaborate work on the source and quantity of work done by hot-air balloons is published by Papper, who shows that the application of air balloons heated by the solar rays, as motors, in place of our present machines which use coal as the source of heat and work, is not likely to unite economy with moderate size.

The important hygrometric studies of Dufour have been continued by him, and form the basis of a second memoir on hygrometric diffusion through partitions of porous earthenware. The results obtained in his earlier researches are fully corroborated, and minuter investigations have led to still further elaboration of the same complex subject. It would appear, however, that the hygrometer composed by him originally may still be relied upon, although each special instrument must require careful investigation and comparison with the standard. This hygrometer being adapted to give continuous records like that employed by Bache at Philadelphia, and being far less troublesome in its operation, may possibly come into general use.

The correction of hygrometric observations for the altitude of stations above sea-level, which is very large at altitudes exceeding a few thousand feet, but which is frequently neglected by meteorological observers, can be made very easily by means of the table published by Hotier in the last annual report of the Commission du Pic du Midi.

The ninth annual report of the Warden of the Standards in London gives, besides current work, a special account of the recent reverification of official standards of weight, capacity, and length. Among the appendices a description is given of the new balance designed by Mendeleff, one peculiarity of which is that it has very short arms, although adapted to weigh large masses.

Some very interesting aerodynamic experiments have been suggested by Professor Tait in connection with the dead heat arrangement proposed by Sir William Thompson for delicate chemical balances. This arrangement is very sensitive to the least current of air blowing upon it, and may be made the means of investigating the diminution of pressure that takes place in a direction at right angles to any current of air.

A series of observations has been instituted by J. W. Osborne, of Washington, who has proposed that observers keep a record of the temperature and its changes so far as they are sensible to the human body, and can be estimated without regard to thermometers or other instruments. He has, therefore, provided a scale of terms from one, which is unendurable cold, to twenty, which is unendurable heat. A large number of observers having volunteered to assist him in Washington and its vicinity, he has been able to show that very satisfactory agreements exist between the estimates of different observers, and that the diurnal and annual changes in sensible temperature are well marked. From such observations as these he hopes to obtain an idea of the relative climates of different portions of the world, so far as they affect the human system, more satisfactory than can be deduced from the study of ordinary meteorological and instrumental records. Observers in Washington and in Ohio have co-operated in this system.

Professor Wild, of St. Petersburg, has introduced a new form of siphon barometer, which consists essentially of two vertical tubes firmly inserted into the closed cisterns. It is said by him to be more accurate than the ordinary cistern barometers, although also heavier and more costly.

The same physicist has also published a careful comparison of wet and dry bulb thermometers, observed both with and without a brisk artificial ventilation. He finds the effect of the artificial currents quite insignificant as regards the dry bulb; but they, of course, lower the wet bulb, and sufficiently in the summer time to diminish the apparent humidity. On the average, however, he concludes that the ordinary thermometer screen, without ventilation, gives the temperature of the air accurate to one twentieth of a degree Centigrade.

Theorell invented, for the use of the Swedish Arctic Expedition, an anemometer which maintained a continuous register for the direction and velocity of the wind, notwithstanding the intense cold to which it was exposed. A full description of it has been recently published in Wijkander's Memoir, in the 12th volume of the Swedish Academy.

The study of solar radiation by the apparatus invented by Violé has been prosecuted by him by means of observations made on Mont Blanc, and at lower stations. He concludes the temperature of the solar surface to be about 1500° Centigrade.

Dr. Robinson, of Armagh, has made an important contribution to anemometry by the publication of a new analytical theory of his well-known anemometer.

Du Claux shows that mixtures in definite proportions of crystallizable salts in water deposit their crystals at very definite temperatures, and may therefore be used, in some cases, as thermometers.

Jannsen has, by means of temporary apparatus at Montmartre, been taking daily photographs of the sun. He records that during the cold spell in France, the first part of May, there were no solar spots visible—a fact quite in accordance with other investigations, according to which, in high latitudes, the coldest seasons occur when few spots prevail on the sun.

Professor Houston, of the Philadelphia High School, states that he is at work on a proposed improvement of the barometer, in which he hopes, by means of a scale floating on the surface of the mercury, to read with greater ease and precision the atmospheric pressure.

Dr. Hellmann, in his discussion of wind observations, suggests that we need instruments which shall measure both the vertical and the horizontal components of the motion of the wind.

C. Investigations and Results.

Professor Loomis has continued his contributions to American meteorology, which have been uniformly published in the *American Journal of Science* after having been first presented to the National Academy of Sciences.

In his fifth paper he gives a collection of data relating to hurricanes, and deduces for American storms a connection between rainfall and the progress of storms.

Maquenne has made an important determination of the power of leaves to absorb and radiate heat. His experiments, of course, were conducted at temperatures not exceeding 120°; and the radiative powers averaged from 91° to 97°; while the absorptive powers varied from 94° to 97°, lampblack being adopted as the standard of comparison.

Dr. Hellmann has contributed a discussion of the observations made by the Army Signal Office at Mount Washington. He finds the diminution of temperature with altitude agrees nearly with that prevailing in Central Europe. The diminution is most rapid with northwest winds, and least rapid with southeast winds.

In a review, by Caspari, of a rare work, by Isaac Vossius, "De motu Marium et Ventorum," published at the Hague in 1663, it is claimed that Vossius was the first to definitely promulgate the rule that it is the rising and falling of the barometer, and not simply its absolute height, that should guide us in predicting the weather.

Considerable light has been thrown upon the formation and activity of ammonia in the atmosphere by the works of Schloessing and others, according to whom the direct assimilation of simple gaseous nitrogen by plants, and the emission of ammonia, is not admissible. The formation of ammonia is by them attributed to the chemical action of ocean water upon the nitric acid carried into it by rain and rain-water.

The effect upon the barometer of any movement in the air is deduced by Montigny from observations in the tower of the cathedral at Anvers. He concludes that the barometric pressure diminishes less rapidly during west winds, and most rapidly during east winds.

Ley finds that of 800 storms passing near Great Britain during nine years, the large majority had a tendency to move in directions parallel to the trend of the steepest gradients; thus when the isobars are closest on the southeast side, the tangents trend toward the northeast, and fifty-five per cent. of these storms move in the same direction. He finds also evidences of a less important disturbing force tending to make the depressions move toward the northeast by east. It would be interesting to compare Ley's rules with the behavior of American storms. We can see no reason why they should obtain for the storms occurring between the Rocky Mountains and the Atlantic coast.

Blanford, of Calcutta, has published a memoir on the winds of Northern India, which is a very fine example of inductive reasoning. His object has been to describe normal wind-currents of Northern India and their annual variations, and to trace out their origin and causes in so far as these can be discovered in the local physical changes in the atmosphere. These causes are, of course, found in the variable moisture and heat, and the peculiar topography of India. Very well drawn charts are given, showing the relation between the movements of the winds and the clouds.

Mr. Blanford's conclusions with regard to the origin of the cyclones of the Bay of Bengal apparently accord best with what we know of similar storms elsewhere. "They form in a region of calms or variable winds; an area of barometric depression and rising temperature is formed several days before the cyclone is generated; currents of air set in converging toward this area; finally, if among these currents there rushes in a strong southwest or west-southwest current of air saturated with moisture," this furnishes the required abundance of vapor, whose rapid condensation gives out the heat required to form and maintain a cyclone, instead of the small tornadoes that would otherwise be the only result.

In reference to the relation between solar radiation and terrestrial meteorology, Blanford remarks that in India both the annual and diurnal changes in temperature are the reverse of the changes in humidity; it would therefore seem that throughout the world, since there is more water than land surface, the principal effect of an increase in the temperature of the sun would be to increase the quantity of moisture in our atmosphere, and to diminish the temperature of the air at the immediate surface of the earth.

Planté states that he has observed certain effects that go to show that the formation of hail is due to an electric discharge of low tension accompanied by a gyratory movement of the electrified particles of ice.

Gronemann has published additional developments of his theory of the origin and nature of the aurora, which is that it is an electric discharge among particles of cosmic dust, clouds of which are encountered by the earth in its annual course around the sun. He finds the explanation of the geographical distribution of the greatest auroral frequency in a zone lying between the parallels of 50° and 70° of north latitude to consist in the relation between the position of the earth's axis and the orbits pursued by the cosmic dust. According to this theory there may be periodical auroras — one of which may possibly recur on the 4th of February.

Fritz has compared the frequency of auroras, as recorded in his great catalogue, with Wolf's observations of the sun-spots. He finds that the most important auroras agree accurately with the minima of sun-spots, and that the great aurora period of fifty-five and a half years also agrees with five of Wolf's sun-spot periods: he even thinks it probable that a still longer period of two hundred and twenty-two years may be detected in the records of the auroras.

Buys Ballot and Wild have published extensive researches upon the distribution of atmospheric moisture or relative humidity in Europe. The former finds the data sufficiently extensive to justify the formation of monthly means and corresponding deviations from the normal values; he also deduces the influence of altitude above sea-level, and of latitude, longitude, and the neighborhood of the ocean.

Hann has published an essay on the climate of the Punjab. Among the many interesting items we note that the average range of temperature in a day is from 16° to 20° Centigrade at the three stations where observations have been made for several years; the actual temperatures averaged 33° Centigrade in June, and 10° Centigrade in January. The comparative dryness of the air is seen from the fact that the average humidity throughout the year is about fifty per cent. The observations at some of the high stations seem to suggest that the minimum temperatures at an altitude of 7000 feet are possibly higher than the corresponding minima in the low lands. Among the stations showing a large rainfall we notice Kangra, where the annual fall amounts to 110 inches, while at Simla and Dehra the corresponding amounts are fifty and sixty inches.

Professor Langley, in an article on the solar atmosphere, gives the results of his measures of the distribution of heat and light over the solar disk; the absorption of heat takes place, he thinks, principally in a thin stratum at the base of the chromosphere. The slightest change in the solar atmosphere has an appreciable effect on the absorption, so that we have here at hand a sufficient cause for those variations in solar heat that geological observations seem to demand. The absorption is also selective, so that the sun tends to have a bluish tinge when the absorbing layer is thin, but to have a reddish tinge at other times, affording us thus some rational hypothesis whereby to explain the phenomena of variable stars.

The influence of atmospheric moisture upon the absorptive power of the atmosphere has been further illustrated by Hoorweg, who has, by a renewed series of observations, conclusively shown the general correctness of Tyndall's results, according to whom a small percentage of vapor in the atmosphere increases enormously the absorption and radiation of obscure heat, and moderates terrestrial climates.

More recently still Lohse has, with great acumen, discussed the observations of Tyndall, Magnus, and Wild, and has added an excellent investigation of his own, showing that the effect of aqueous vapor is by no means as decided as maintained by Tyndall.

The relation of warm, dark heat rays to hydrogen and the atmosphere has been studied by Buff, of Giessen, who has repeated a series of experiments bearing on the absorption of heat by the atmosphere, and concludes that hydrogen is as nearly transparent to heat as a vacuum, while dry air absorbs fifty or sixty per cent. of heat rays. The assumption of Tyndall that the power of damp air to absorb rays of heat coming from a dark source exceeds by fifteen to forty per cent. the absorptive power of dry air is incorrect. It is correct, however, to say that such heat rays as are not absorbed in dry air can become absorbed, or do experience a very sensible diminution when passing through damp air.

Mendeleff endeavors, by means of Poisson's equation, to arrive at formulæ by which we may calculate the temperature of rarefied air with a high degree of approximation. In reference to the expansion of air by heat, he has shown that for pressures between 750 and 770 millimeters the coefficient of dilatation of the air is 0.00036843 for 1 degree of Centigrade.

An excellent contribution to our knowledge of the chromatic dispersion of gases has been made by Lorenz, of Copenhagen; and his investigation of the coefficient of refraction of aqueous vapor will find an important application in the spectroscopic study of the atmosphere.

Hennessey has engaged in an elaborate work on the atmospheric lines of the solar spectrum. His observations were made among the outlying hills of the Himalaya Mountains at an elevation of 1700 feet. In this region, near sunset, atmospheric lines are remarkably well developed, and the effect of aqueous vapor is truly startling. There can be no doubt that in the hands of skillful observers the spectroscope must become an invaluable meteorological instrument, and will perhaps eventually give quantitative as well as qualitative indications.

Two very elaborate memoirs are to be found in the official publications of the Italian Meteorological Office. One is due to Denza, on the distribution of rain and barometric pressure in Italy; the other, by Ragona, is on the distribution of temperature.

Professor Reynolds has made a further communication to the Royal Society on the refraction of sound by the atmosphere, fully confirming the positions previously advanced by himself and by Professor Henry. Interesting relations seem to exist between these phenomena and the state of the atmosphere before or during storms, etc.

Jordan, of Carlsruhe, contributes to the theory of atmospheric refractions an article in the *Astronomische Nachrichten*, in which he shows that, without making any assumption as to the decrease of temperature with altitude, we may, by a general assumption as to the curvature of the ray of light, obtain simpler tables and better results than by any of the tables now in use. Inversely, then, the average temperature of the air can be determined from refraction observations, as others have done from barometric observations, and thus valuable new meteorological results arrived at.

An interesting paper, both in a theoretical and practical point of view, is that by Dr. Von Lang, of Vienna, on experiments on the friction between water and air. These experiments were made by measuring the amount of air drawn along after a falling column of water. The friction of air slipping over the surface of water and causing it to slowly follow is one of the important elements in terrestrial physics, and is directly involved in Von Lang's experiments, which have also a direct bearing on the origin of the gust of wind that precedes falling rain and hail.

The severe storm of March 12, 1876, has been the subject of a memoir by Quetelet, according to whom it was the severest that has been observed at Brussels since the period of exact observations at that place.

Montigny contributes an investigation into the law of diminution of pressure in the atmospheric strata during storms, and shows that according to the direction of the wind and the condition of the barometer as to rising or falling very marked deviations may be noted at moderate altitudes from the normal distribution of pressure. For instance, during easterly winds in Belgium, the barometer at the upper station is low, during westerly winds it is high.

Von Bezold has published a second memoir on the phenomena of thunder-storms in Europe, in which he shows that there is a pretty well marked double maximum during the summer months in the northern hemisphere, and that these maxima are the better distinguished from each other in proportion as we go farther away from the equator; wherefore he suggests that they may be considered as due to the existence of the two summers of equatorial regions, or, in other words, that they follow the two passages of the sun across the equator in the course of the year.

The diurnal variability of temperature has been investigated by Hann, who has extended his observations to a large number of stations scattered throughout Europe and Asia. He shows that the daily variability reaches its maximum in the interior of North America. A second region of maximum is found in Western Siberia, at a higher latitude than in America.

The shores of the Caspian and Baltic are visited by storms of fierce northerly winds, precisely similar to the "northers" of the Texas and Mexican coasts. A detailed study into the phenomena of the Bora, as it is called, at Novarussisk, has been published by Baron Wrangell. According to him, the violent winds that visit this fine harbor acquire their force from the fact that they consist essentially of cold dense air, which descends the mountain-sides. He calculates theoretically the violence of the wind; and having shown the satisfactory agreement of his formula with actual observation, concludes that his explanation of its origin must be accepted, and thence is led to propose a method by which the harbor may be protected, or, rather, by which the wind itself may be diminished, if not prevented.

The movement of water in rivers has been the subject of a series of very extensive experiments by Captain Allen Cunningham, of India, and his work ranks in importance with that of Humphrey and Abbott, and the recent investigators in Europe.

An excellent memoir has been published by Dr. Armieux on some results of observations made on the Pic du Midi, and especially on the presence of red snow in the Pyrenees, and on the general history and condition of the question as to the exact nature of this phenomenon.

The formation of snow crystals has been observed by Tissandier in a balloon ascension: he notes that a stratum of warm air accompanied the thin stratum of ice crystals; the higher temperature was undoubtedly due to the evolution of heat during the formation of snow.

Van der Mennsbrugghe shows that every disturbance in the surface of a liquid gives rise to electric currents, and deduces thence the conclusion that the change from invisible vapor to condensed drops of fog or rain must affect the atmospheric electricity, while the original evaporation of water from the ocean is a constant source of electric currents; whence he frames a comparatively simple theory to account both for terrestrial electricity and atmospheric electricity.

Lemstrom has developed, in the Geneva *Archives*, his views on the nature and origin of the aurora. His theory regards this as mainly a terrestrial phenomenon, due to electrical discharges through the upper regions of thin air (similar to the discharges through a Geissler tube), and also between this air and the earth; according to him, the upper stratum of air forms a great conductor, which is nearer the earth in the polar than in the equatorial regions.

The aurora of April 7, 1874, has been elaborately investigated by the author in a memoir published in the Annual Report of the Chief Signal Officer of the Army. In a note on the origin of atmospheric electricity, Professor Tait states that he has been making a series of experiments to ascertain the part played by aqueous vapor in the production of atmospheric electricity. While water is in the form of vapor, it must be electrified by contact with the gases of the atmosphere, as they are by contact with each other. He finds that the precipitation of vapor in a receiver, whether produced by cold or by exhaustion of the air, is always accompanied with a disengagement of electricity. Further experiments with receivers of very great capacity are promised by Professor Tait.

TERRESTRIAL MAGNETISM.

No. 14 of the contributions to Terrestrial Magnetism, by General Sir Edward Sabine, is published in Vol. CLXV. of the London Philosophical Transactions. In this he presents the second half of the magnetic survey of the northern hemisphere, of which the first half constituted No. 13 of his contributions. These two papers, taken together with No. 12, which belongs to the southern hemisphere, embrace fully three fourths of the entire globe. In the present paper, declination, inclination, and magnetic force in British units, and corrected as far as possible to the epoch of 1842.5, are given for all available stations, arranged in four zones 10° broad, from the equator northward. A table is also given, comparing the observations published by Sabine with the formulæ and observations of Gauss and Weber.

The magnetic observations made at twelve of the stations occupied by the Transit of Venus parties were conducted in accordance with instructions emanating from the Observatory at Stonyhurst, in England. They were continued for about five months at intervals of every two hours, and will afford valuable data relating to terrestrial magnetism.

The Bureau of Longitudes at Paris has published a map of magnetic variations for France, for 1876, prepared by Marié Davy, which will hereafter be issued annually in connection with the *Annuaire* of the bureau.

Lieutenant Weyprecht presents a synopsis of the results of the magnetic observations made by the Austrian Polar Expedition under his command in 1872–1873, in which he states that declination, inclination, and total intensity are greater in the regions traversed by himself than as given by General Sabine for 1840–1845, and than those computed by Erman and Petersen for 1829, according to Gauss' formula. His observations of daily variation are the only ones as yet published from arctic regions, except those made at Lake Athabaska and Fort Simpson. From them it seems to result that the total intensity suffered little or no variation in consequence of the magnetic perturbations, which latter affected only the declination and inclination.

VULCANOLOGY.

Of recent publications in reference to earthquakes, we should mention the two important volumes by Schmidt, at Athens, one of which, "Studies on Earthquakes," affords the best collection extant of statistics of this phenomenon and its relation to the moon, the barometric pressure, etc. The second volume, "Studies upon Volcanoes," is especially devoted to Santorin, Vesuvius, Baie, Stromboli, and Etna. In his observations upon these volcanoes, Schmidt has combined the accuracy of an astronomer's studies with the caution of the true investigator.

Serpieri has subjected to a detailed study the observations of earthquakes that have been made in Italy by means of delicate pendulum seismometers. According to Alexis Perry, Serpieri's memoir is one of the most important that has lately appeared on this subject.

Pictet has communicated to the Society of Physical Sciences at Geneva the results of his experiments made in Egypt on the propagation of the heat rays of the sun through different substances, especially sand. He had proposed to himself to verify the idea suggested by Sorat, that the sand acted somewhat like a sheet of glass; that is to say, that it was diathermanous for luminous heat, and athermanous for obscure heat. Pictet has found that in the diurnal changes of temperature a much greater accordance takes place between the sand and the glass than other substances, like wood or coal, even when these two latter have been painted the color of sand.

Mohr shows that the observations of temperature in the artesian well at Sperenberg conclusively demonstrate that as we descend into the earth the rate of increase of the temperature steadily diminishes, and that therefore, at a given depth, the temperature must become stationary. It follows that the origin of the internal heat of the earth is to be looked for, not in the presence of an internal molten nucleus, but in the chemical or other action going on in the strata themselves. This result is, however, ably controverted by Dunker and Moesta.

In the *Annual* of the Imperial Geological Institution at Vienna we find an essay on springs and their formation, by Dr. E. Tietze.

The study of the internal heat of the earth is much facilitated by lists of thermal springs, such as that compiled by Dr. Gilbert, of Professor Hayden's Survey, and published officially by him. The connection between the thermal springs and the disturbed or undisturbed condition of geological strata is clearly shown by the chart which accompanies Mr. Gilbert's paper.

The submarine explosion at Hell-gate, under the direction of General Abbott, was taken occasion of for measuring the velocity with which the shock was communicated through the earth. Four delicate seismometers were established at stations distant respectively 5, 9, 8, and 13 miles. The velocities of transmission for the corresponding stations were respectively 39, 45, 83, and 53 hundred feet per second. The shock received at each station was of the nature of a continued vibration, and not a short, sharp one. The observers at the stations lay upon the ground and listened to the rumbling of the earth, which occurred simultaneously with the sound. The discordant determinations of the velocity probably should be attributed to the various natures of the strata of rock and earth through which the sound was transmitted.

PHYSICS.

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The progress in physical science has been fully up to that of previous years. In *General Physics*, Crova has suggested a most excellent experiment for showing the relation of heat, electricity, and mechanical work to each other. The apparatus used is a Clamond thermo-battery, a Gramme magneto-electric machine, and a coil of platinum wire inclosed in a glass globe. First, if the wire coil be attached to the battery alone, the heat from the gas flame, transformed into electricity by the battery, reappears as heat in the external circuit. Second, if the Gramme machine be put in the circuit in place of the coil, the electricity developed by the heat is transformed into mechanical work, and the machine acts as a motor. Third, if both coil and machine are put in circuit, heat is produced in the coil, and work in the machine. But if now the machine be stopped, the incandescence of the wire is increased; as it gradually acquires velocity again, the glow of the wire is reduced. The expenditure of heat necessary to produce a given quantity of work is thus made evident to the eye. Finally, if the machine be turned by hand in the direction of its previous rotation, the incandescence of the wire diminishes, until finally a velocity is reached at which the wire no longer glows at all. But if the rotation be in the opposite direction, the incandescence increases until the wire fuses. The additional energy introduced appears as heat.

Ettingshausen has made an ingenious use of the stroboscopic method of Mach for the purpose of studying the uniformity of motion of rotating bodies. The rotations compared were obtained with an electro-magnetic motor with Helmholtz's regulator and an accurately constructed clock-work. The former of these gave the most uniform motion.

Another noteworthy event has been the presentation to the Royal Society of a paper by C. W. Siemens, describing an instrument to which he gives the name of bathometer, and by which the depth of water at any point in the ocean may be ascertained by simple inspection, without the use of a sounding-line. It consists of a vertical column of mercury inclosed in a steel tube having cup-like extensions at its ends. The lower end is closed by a corrugated steel diaphragm, the weight of mercury resting upon it—which is of course affected by the force of gravitation—being balanced in the centre of the diaphragm by the elastic force of four carefully tempered steel springs—which is independent of any variation of gravity. Being open to the atmosphere both above and below, the instrument is unaffected by variations in the pressure of the air. The peculiar form of the column was given to it in order to render the instrument parathermal, or independent of temperature. The reading is effected either by electric contact or by means of a spiral graduated tube fixed on the top of the instrument, and communicating with the space above the mercury, which contains a liquid of less density partially filling the tube. The graduations are empirical, since this is much easier than calculation. Experiments in the *Faraday* with Sir William Thomson's sounding-line gave 82 fathoms at 12, 204 fathoms at 1.08 P.M., and 69 fathoms at 2.20; the bathometer showed 82, 218, and 78.

In *Mechanics*, Kimball has published the results of some experiments made by him to ascertain whether the coefficient of sliding friction is constant at all velocities, as it is ordinarily stated to be, or whether it varies inversely as the velocity, as certain practical results seem to render probable. The figures given show: (1) that with a given inclination of the plane, the coefficient of friction decreases as the velocity increases, rapidly at first, but more slowly afterward; (2) with the same velocity, the coefficient of friction is greater the greater the inclination of the plane, within the limits of the experiments; (3) that the coefficient of friction in each experiment tends toward a constant quantity; and (4) this constant seems to be the same in each experiment.

The same physicist has studied the changes produced in the physical properties of steel by tempering. He finds (1) that the modulus of elasticity decreases as the hardness of the steel increases; (2) that the increase of deflection in a given time is greater the harder the steel; (3) that the immediate set increases with the hardness of the steel; and (4) that a bar recovers from a temporary set with greater rapidity the harder it is.

The process of M. De la Bastie for hardening glass has met with a formidable rival. F. Siemens, the well-known Dresden manufacturer, has patented a method of hardening, tempering, and pressing glass all at the same time. Instead of plunging the softened glass in a bath of cold oil, the molten glass is run into suitable moulds, and while still highly heated is squeezed, the moulds—which are generally of metal—having the effect of giving the necessary cooling. For blown glass, shells or casings of platinum are made, and these are transferred to the mould together with the glass.

Lawrence Smith has devised a simple form of compensating pendulum, founded on the considerable expansibility of hard rubber or vulcanite by heat. The seconds pendulum he uses consists of a steel rod 6 mm. in diameter, over the lower end of which is passed a tube of vulcanite 25 mm. in diameter and 165 mm. long, secured by an adjusting screw at the lower end of the pendulum rod. A brass bob 63 mm. in diameter and 156 mm. long slides over this vulcanite tube, and rests upon its top. The upward expansion of the vulcanite should be equal to that of the steel rod and the bob downward. The coefficient of expansion for 1° Centigrade of the vulcanite was 0.000079365.

Cailletet, who has been working upon the problem of chemical action under high pressures, has contrived a simple form of pressure gauge, founded on the compressibility of glass. By experiment he proved that a cylindrical glass reservoir suffers, when compressed, a diminution of volume exactly proportional to the pressure exerted. The new manometer consists, therefore, of a large glass thermometer, with a cylindrical bulb containing either a colored liquid or mercury, and inclosed in a cavity in a steel reservoir, communicating by a brass tube with the apparatus in which the pressure is to be measured. To maintain the temperature constant, the whole apparatus is placed in melting ice during use. The indications are reliable.

Parish has described a simple form of balance for taking specific gravities of solids, constructed somewhat like a common form of letter scale, with unequal arms, the substance being placed in a pan (which can be immersed in water) at the end of the shorter arm, while the longer is graduated directly to give the specific gravity.

Schott has examined the character of the crystallizations which are produced in common glass under various conditions, with a view to elucidate the chemical character of glass itself.

Nipher has published a paper on the variation in the strength of a muscle, in which he calls attention to the fact that after the relation of the strength of a muscle to the dynamical work of exhaustion has been determined, its strength at any time is easily found by measuring the dynamical work of exhaustion. He also finds that the coefficient of power of a muscle per square centimeter of its section is very variable; so that the work a muscle can do depends not alone upon its size, but also upon its quality.

Victor Meyer has devised a simple and very effective method of determining the solubility of salts in solvents, which is rapid and accurate, whatever be the temperature at which the solubility is taken.

Meunier has observed a quartzose sandstone from the vicinity of Orsay, Department of Seine-et-Oise, France, perforated through and through by the roots of trees. The grains of quartz are held together by a calcareous cement, which is the material upon which the carbonic gas exhaled by the roots has exerted its solvent action. These roots were those of the elm, and were of all sizes, from a centimeter and more to less than a millimeter in diameter. The author thinks that possibly in this way roots may insinuate themselves into rocks far anterior in age, and thus be regarded as much older than they really are.

Lescœur has studied the influence of chemical character upon the gyratory motions which are observed whenever certain substances, such as camphor, for example, are placed on the surface of pure water. He has obtained the result with the acids belonging to the fatty series and with many of their acid salts, though only in a slight degree with normal salts. A fragment of glacial acetic acid, for example, moves very actively on water and dilute acetic acid, but not on the concentrated acid or on mercury. So also of propionic, butyric, and valeric acids.

May has published a memoir on hydrodiffusion, or the diffusion of a heavier liquid into water, in which he gives experimental and mathematical evidence to sustain the hypothesis of Fick—or a modification of it—that the passage of a dissolved substance from one solvent to a second proceeds according to the theorem which Fourier established for the passage of heat along a conductor.

Guthrie has investigated the conditions of production of stationary liquid waves in both circular and rectangular troughs, intending therefrom to deduce the velocity of wave progression from the frequency of the recurrence of a given phase in the same place. With circular troughs he noticed that with binodal motion—*i. e.*, motion produced by oscillations at the centre—the number of vibrations is independent of the amplitude and of the temperature; that the normal rate of pulsation is not reached unless there is a depth of at least six inches; that the chemical nature of the liquid is without effect on the rapidity of oscillation; that the rapidity of progression of such waves varies directly as the square root of the wave length; and that the nodal line of such circular waves is one sixth of the diameter from the circumference. Hence it follows that a wave a meter long would travel 83.07 meters a minute, or a little more than three miles an hour.

Marey has published a valuable memoir on the movements of liquid waves in elastic tubes, in which are given the results of experiments made to elucidate the circulation of the blood, particularly with reference to the character of the pulse as determined with the author's well-known sphygmograph. By means of a very ingenious little apparatus called an explorator, several of which are placed along the length of the tube through which the wave moves, compressed air is made to move a style at the instant the wave passes. This style records the movement, both in time and in form, upon a blackened cylinder, whose surface moves twenty-eight centimeters per second. The author's conclusions from these experiments have a high physiological importance.

The same author has contrived an ingenious dial log for vessels, by which the speed of a vessel at any given instant may be ascertained by inspection. It consists of two corrugated circular boxes like those used in aneroid barometers, but not exhausted, the one side of each of which communicates with a tube passing into the water. These two tubes are bent at right angles at their lower ends, and face opposite ways. The inside faces of the boxes are connected by means of a rod having rack-work upon it, into which gears a pinion upon the arbor of an index hand. Should the pressure in one box be different from that in the other, the rod would move, and the index too. But whatever the absolute variation of pressure, provided it is the same in both boxes, no effect is produced on the dial. By means of connecting tubes and an aspirator, the whole apparatus is filled with water. Then it is unaffected by the vessel's pitching and tossing, and indicates only the speed with which she passes through the water. By simple means it may be made self-recording.

Romilly has studied the action of a current of air or steam in drawing into its course the surrounding air, using for this purpose various forms of openings and ajutages. The same results were obtained with air and steam, the maximum pressure in the receiver being obtained when the receiving cone has an angle of 5° to 7°, the base directed away from the jet. This latter is placed at a distance from it determined by making the jet the apex, and the opening of the receiving tube the base of a cone of 15°. Then the quantity of air drawn in is directly as the diameter of the two openings (of the jet and receiving cone); the velocity is in the inverse ratio; the pressure is inversely as the section of the receiving tube, the absolute pressure varying according as the receiver is opened or closed. He has also observed that, using a receiver with thin walls, if the jet be removed only a few millimeters from it, and directed not into the opening of this receiver, but just outside of it, and upon the wall itself, a maximum of pressure is produced more than double of that obtained when the jet enters the orifice. Using a jet provided, like the receiver, with lateral walls, there is no longer a pressure, but an aspiration produced, even at considerable distances.

Penaud has presented to the French Academy an important memoir on aviation, in which he describes his new apparatuses for mechanical flight. He divides the systems of aviation already proposed into three classes: helicopters, aeroplanes, and orthopters. In the first, screw-propellers with nearly vertical axes constitute the sustaining power; in the second, the surfaces are nearly plane, inclined slightly to the horizon, and the apparatus is propelled by screws; the third are furnished with organs whose surfaces have nearly vertical and alternating movements. In 1870 one variety of helicopters was constructed which would rise to a height of fifteen meters, and remain in the air for twenty seconds. In 1871 an aeroplane was presented to the Society of Aerial Navigation, which was most successful. But a year later a mechanical bird was produced which essentially solved the problem.

Moreau has made a series of experiments to determine the precise function of the swimming-bladder of fishes. He shows very ingeniously that fishes which possess such a bladder undergo variations of internal pressure, and hence that they do not, as is generally stated, make use of muscular power to preserve their density unaltered when this pressure changes. The function of the swimming-bladder, then, in Moreau's opinion, is to enable the fish to adapt itself to all depths, not by a mechanical action exerted upon this by means of its muscles, but solely by changing the quantity of air which is contained in this organ.

Wagner has made an investigation of the accuracy of the results obtained with the effusion apparatus of Schilling for determining the density of gases. Three perforated platinum plates were used, having holes of different sizes. With coal gas the density was 0.46 with the largest, 0.47 with the mean, and 0.48 with the smallest opening. Oxygen gave 1.21, 1.08, and 1.21 under these conditions, the true density being 1.10. Hydrogen gave 0.22, 0.20, and 0.23, its actual density being 0.069. Carbonic acid gave 1.51, 1.36, 1.36, instead of 1.52. For gases other than coal gas, therefore, the method is inaccurate. And even for this the variation from the actual density, as determined by the balance, was 0.03, a value of great importance so far as the illuminating power is concerned.

Lecoq de Boisbaudran has proposed a simple form of cock for gas or water. In the middle of a piece of small glass tube a plug is firmly fixed, and a hole is bored into the tube on each side of it. A short piece of larger tube is taken, a cork thrust into it about half its length, bored to receive the first-mentioned tube. This cork has a lateral opening. Both ends of the larger tube are closed with corks, the smaller passing through them. If now the hole in the smaller tube be opposite the lateral opening in the cork within the larger tube, there will be a free flow of water or gas through the whole; but by rotating the tubes half round, the opening in the tube is closed by the cork, and the flow ceases.

ACOUSTICS.

Mercadier has published the results of his experiments on the vibration of steel forks, from which he concludes, first, that the number of vibrations of such forks, other things being equal, is independent of their breadth; second, that the number of vibrations is directly as the thickness; and, third, that this number is inversely as the square of the length. These results are in complete accordance with those calculated from the theory of elasticity in solids. With regard to the amplitude of the vibration as affecting its isochronism, the author concludes, first, that the vibrations of a fork are not absolutely isochronous, the duration of its period varying with the amplitude and the temperature; second, that consequently any chronographic instrument can give comparable results at different times only if the temperature and the amplitude remain the same; and, third, that if the amplitude does not exceed three or four millimeters, and if the temperature varies but slightly, the number of periods per second may be exact to 0.0001 nearly.

Mayer has given in *Nature* some notes of remarkable experiments in acoustics on the obliteration of one sound by another. He finds that the ticking of a clock, for example, completely obliterates the ticking of a watch at the periods of coincidence, the intensity of the clock ticks which effect this obliteration being three times that of the watch ticks. Moreover, he observes that a sound can not obliterate another lower in pitch than itself—a result of great physiological significance. These facts the author applies to orchestral music, and shows that this obliteration of higher by lower sounds should and does seriously mar the intended effect of the music, and hence that the study of its conditions is necessary in musical composition.

The same physicist has published a preliminary note on two new methods of research in acoustics, in which he asks the privilege of being permitted to develop them. The first is a plan for the determination of the relative intensities of sounds of the same pitch. This is effected by placing a loose membrane any where between the centres of origin of two sounds of the same pitch, and perpendicular to the line joining them, and then by any device determining the position where the membrane ceases to vibrate. The instrument he calls a phonometer. The second is a method for determining the direction of sounds. It consists of a membrane capable of being moved in any azimuth, and which can therefore be placed at right angles to a sonorous wave front. When it reaches this position it can not vibrate, since the impulses are alike on the two sides. To increase the aural parallax, two resonators may be used at the ends of a horizontal rod.

Dvorák has studied certain attractions and repulsions observed in the vicinity of sonorous bodies when they are vibrating. If, for example, a rod of wood be made to vibrate slowly, and a small square of paper suspended by a silk filament be moved slowly around it, the surface of the paper being preserved vertical, it will be noticed that in certain positions there will be attraction, and in certain others repulsion of the paper. The author attributes these movements to currents of air generated by the vibrating mass, and proves his theory by a number of highly interesting experiments.

Müller has experimented to determine the pitch of the notes given by transversely vibrating rods of gypsum when dry and when moistened with various liquids. His results show (1) that the changes in tone produced by the absorption of liquids are also accompanied by a variation—actually a decrease—in the coefficient of elasticity; this effect is most marked with water, less with alcohol, and still less with oil; and (2) the variations of tone of the various rods when wet, in comparison with a dry rod, follow a definite law, a comparison of the condition of such a rod when it has taken up a liquid showing a change in its modulus which is quite definite in amount, and depends only on the liquid employed.

Bosanquet has communicated to the Musical Association a second paper on temperament, or the proper division of the octave, in which he considers carefully all that has been done in the subject, and suggests a plan of his own for the purpose. To test the question, he has had a harmonium constructed with a compass of only four and a half octaves; but as each octave has fifty-three keys (!), the number of notes is quite sufficient. A previous instrument had eighty-four keys in each octave.

Professor Foster has exhibited to the Physical Society of London the apparatus devised by Mach for sound reflection. It consists of a mathematically exact elliptic tray, highly polished, and provided with a tightly fitting glass cover. The tray is covered with precipitated silica well dried. Upon repeatedly discharging a Leyden-jar between two small knobs placed in one of the foci, the finely divided silica is seen to arrange itself in curves around the other focus.

HEAT.

Wallace has made a series of experiments on the Bunsen burner, with a view to utilize it for general heating purposes. In one form of burner devised by him the tube contains a simple strip of metal so folded as to split up the rising currents, and so producing an intimate mixture of the gas and air. Such a burner will not strike down. In another form, called by him the tangent burner, the gas enters a circular chamber tangentially, drawing in the air with it. In this way the two are thoroughly mixed; and if now they pass into the tube of the burner through a piece of gauze at its base, the burner is safe and trustworthy under all variations of pressure and quality of gas. To utilize the burner for heating purposes, the author proposed a stove six feet high and fifteen inches in diameter, with a partition dividing it vertically from the bottom to within six inches of the top. The burner is at the bottom of one division, and the outlet pipe at the bottom of the other.

Puluj has described a simple and easily constructed form of apparatus for determining as a lecture experiment the mechanical equivalent of heat. It consists of two truncated cones of cast iron, one of which is fixed, the other movable, revolving within the first and in contact with it. The power consumed is measured by a kind of Prony brake arrangement, and the rise of temperature by a thermometer placed in mercury in the inner cone. The mean result given by fifty-seven experiments with this machine is 426.7 kilogramme-meters.

Puschl has investigated the fact, observed by Schmulewitsch, that caoutchouc when free dilates by heating, but that when stretched it contracts. From the theoretical consideration that the elasticity of a body increases with the temperature when at a maximum of density, and decreases when the density is a minimum, the author concludes that caoutchouc has a minimum density, the temperature of which diminishes as the tension increases. This temperature is above the ordinary temperature for caoutchouc without tension, the coefficient of dilatation being positive; it is inferior to the ordinary temperature for strongly stretched caoutchouc, the coefficient being negative.

Violle has experimentally investigated anew the question of the sun's temperature. He used a thermometer, carefully made, reading to one fifth of one degree, and blackened, placed within a copper sphere, also blackened. A second sphere of copper, externally polished, surrounds the first, the space between them being so arranged as to have a constant current of water of any desired temperature conveyed through it. On opposite sides of these concentric spheres are tubulures by which the solar radiation enters, closed by a plate having several openings of different sizes. His results, when reduced, show that every square centimeter of the earth's surface at the places named receives the number of units of heat (gramme-degrees Centigrade) placed opposite:

Summit of Mont Blanc	2.392
Grands Mulets	2.262
Glacier des Bossons	2.022
At the level of Paris	1.745

Assuming the correctness of Dulong and Petit's law, calculation from these numbers gives 1500° Centigrade as the temperature of the sun. But not desiring to assume this, Violle made direct experiments with his apparatus upon the heat radiated from Siemens-Martin steel when running into the moulds. From the data obtained he gives 1300° Centigrade as the temperature of the metal. This increases only a little the previous value; and after making all the allowances fairly demanded, the author maintains stoutly that the mean temperature of the sun does not sensibly differ from 2500° Centigrade.

Jannetaz has studied the propagation of heat in crystallized bodies in an ingenious manner. Instead of perforating the crystal plate, as has been done by previous experimenters, he used a small truncated cone of platinum, having on each side of its base a platinum wire leading to the battery. The crystal plate is previously covered with some easily fusible substance (the author prefers lard), the little cone is brought upon its centre, and the circular or elliptical form of the liquefied portion of the covering material becomes very soon apparent. By this means Jannetaz has obtained some very curious results.

Maumené has communicated to the French Academy the results of his experiments on the temperature produced by mixing together olive-oil and concentrated sulphuric acid, in which he calls attention to the remarkable fact that the evolution of heat is greater if the acid has, just before use, been heated to ebullition. The same fact is true, he thinks, of other bodies having a high boiling-point. Such bodies by thus being heated suffer no proper chemical alteration, but undergo, apparently, a change in molecular structure, the evidence of which is a variation in the number of calories produced in their chemical actions. For example, fifty grammes of olive-oil mixed with ten cubic centimeters of acid recently boiled produce a rise of temperature of 42°. Using a specimen of acid two months old, of specific gravity 1.845, the rise was only 34.5°; the same acid freshly distilled gave a rise of 44°.

Witz has experimented successfully with the freezing mixture suggested by Pierre and Puchot, *i. e.*, a mixture of hydrochloric acid and snow. He finds, for example, that 250 grammes of fine snow at zero mixed at once with 250 grammes of hydrochloric acid (commercial) of specific gravity 1.1823, at —1°, give in the course of one minute a solution having a temperature of —37.5°. If the acid be cooled previously to —18°, the mixture produces a cold sufficient to freeze mercury very readily.

Page has described a simple form of gas regulator, which has the especial advantage that it is not affected by variations in the barometric pressure. It consists of a mercurial thermometer, the stem of which is three sixteenths of an inch in inside diameter and open at the top. The gas is admitted through a fine tube which is placed within the thermometer tube, so that the rise of the mercury within this cuts off the supply of gas when the desired temperature is exceeded. This regulator kept a beaker of water for four or five hours within a range of 0.2° Centigrade, and kept the temperature of an incubator for six weeks within 0.5° Centigrade.

The intimate relation between the diffusion, the viscosity, and the conductibility of a gas on the mechanical theory of heat renders interesting some careful experiments of Kundt and Warburg upon the last two properties of gases above given. The results obtained give for the friction coefficient of air at 15° the number 0.000189, for hydrogen 0.0000923, and for carbon dioxide 0.000152. The value obtained for aqueous vapor was 0.0000975. The correspondence between these numbers obtained in a good vacuum and those of Graham and Maxwell at ordinary pressures, proves that this coefficient is independent of pressure. The coefficient of conductibility was determined from the time which a thermometer placed in the gas required to cool. At a certain limit of pressure the influence of convection disappeared, the cooling being due solely to radiation and conduction. By obtaining the most complete vacuum possible, they saw the rapidity of cooling become independent of the form of the vessel, and hence the conductibility is nil. In this way they showed the conductibility of hydrogen to be 7.1 times that of air, while that of carbon dioxide is 0.59. A curious fact observed was that the rapidity of cooling is by far the best test of the perfection of a vacuum.

Duclaux has observed and investigated the curious fact that a homogeneous liquid mixture may, by a change of temperature or by certain additions, become separated into two layers. For instance, a mixture of 15 cubic centimeters of amyl alcohol, 20 cubic centimeters of ordinary alcohol, and 32.9 cubic centimeters of water is homogeneous above 20°; but the least lowering of temperature below this, even by one tenth of a degree, causes the division of the liquid into two nearly equal layers. The author proposes to use this fact in the construction of an exceedingly delicate minimum thermometer. Convenient volumes of amyl and ethyl alcohols are mixed together, brought to the required temperature, and water gradually added, drop by drop, till a slight turbidity results. The liquid is then sealed in a tube, being first colored with carmine. Whenever the temperature falls below that at which it was prepared, the two layers appear, and of different tints. If methyl alcohol and ether be thus used, a maximum thermometer may thus be made.

Berthelot has given a system of classification of acids and bases founded on the decomposition of their salts by water, as shown by the thermal changes which result. In the first class are placed strong acids and bases. These, when separately dissolved in water and mixed in equal equivalents, produce an amount of heat which is nearly constant for all, and which is not increased by a new addition of water or of the base. Such salts, then, are not decomposed by water. The second class includes feeble acids. These form salts, even with strong bases, which are decomposable by water, the decomposition progressively increasing with the amount of water added. With some of the bodies of this class, however, the progress of the decomposition is gradual either up to a certain limit or indefinitely, while with others it is effected totally upon the first addition of the water. In the first class are placed chlorides, nitrates, and neutral sulphates of the fixed alkalies; in the second, the borates, carbonates, cyanides, sulphides, alkali-phenates, acetates, butyrates, valerianates, as well as the alcoholates. The author thinks these results are due to the formation of hydrates of the acid and the base by the water added. In the first class the heat set free by the formation of the hydrates is less, in the second greater, than is evolved by the union of the acids and bases themselves.

The same chemist has examined thermo-chemically the explosion of gunpowder, in order to negative the view expressed by Noble and Abel, that this phenomenon is incapable of exact chemical formulation. He shows most clearly that when powder explodes there are formed all the bodies which are stable in the conditions of the experiment, principally potassium sulphide, sulphate, and carbonate, as well as carbon dioxide, monoxide, nitrogen, and steam. The proportions vary with the conditions of the experiments. These substances, if they remain in contact sufficiently long, suffer reciprocal action which brings them to a single condition, *i. e.*, that which corresponds to the maximum of heat set free. Each of these products is formed according to a regular law nevertheless, and the chemical transformations of the powder are expressed in all cases by a simultaneous system of very simple equations.

Julius Thomsen has published a memoir on the heat of neutralization of chemical substances, in which he gives the following conclusions: the differences observed in the results obtained disappear if the substances used be mixed in aqueous solution. The bases soluble in water are thermally divided into two groups: First, that of the hydrates, represented by potassium hydrate; and, second, that of the anhydrides, represented by ammonia, the typical heat of neutralization being for the first group for one molecule of normal sulphate 31,300 calories, and for the second group 28,200 calories, at 18°. For the insoluble bases only the apparent heat of neutralization can be measured, and this is the sum of the true neutralization heat and that of solution of the base. If the former be the same for the bases of the magnesia series (Mg, Mn, Fe, Ni, Co, Zn, Cu) as for the alkali earths, the heat of solution of these bodies will be negative, that of copper, for example, being —12,800 calories.

The radiometer continues to be the subject of extensive experimentation. Böttger, using a Geissler instrument, could not obtain the slightest rotation with the full moon or with phosphorescent tubes. A candle flame twenty-four centimeters distant, with an alum plate interposed, gave a weak rotation; but with a water cell no motion was detectible. If the instrument be placed in a room at 15° Centigrade, in presence of a gas flame, there is rotation as usual; but if immersed in water at 45°, the rotation is reversed. Lippmann has given a very complete list of the theories which have been advanced to explain the motion of this instrument, the general conclusion being that the energy effective is heat.

Neeson has experimented at length on the so-called mechanical power of light as manifested in the apparatus of Crookes, and comes to the conclusion that the motions observed are due to heat currents produced in the residual air.

The University of Pennsylvania has recently obtained from Geissler one of Crookes' radiometers. It is extraordinarily delicate, the light of a candle three feet distant causing the vanes to revolve, and the rotation being continuous in ordinary daylight.

Von Wartha has made a series of experiments on the influence of pressure on combustion. For pressures greater than that of the atmosphere the experiments were made in the caisson of a bridge crossing the Danube at Buda-Pesth, the manometer there indicating 1.95 atmospheres. Six standard candles were burned for a definite time in the open air and then in the caisson, being weighed both before and after each experiment. The result showed the consumption, as a maximum, to be 17.4 per cent. more combustible in air at the ordinary pressure. In a receiver exhausted to 90 mm. a candle burns with a scarcely visible flame, the cause of which the author believes to be the fact that, as the pressure diminishes, the temperature of dissociation constantly increases.

Cailletet has also published a paper on the influence exerted by pressure on combustion. His experiments were made with a hollow iron cylinder which would stand a pressure of 300 atmospheres, into which air could be compressed by pumps. The flame to be examined was placed in this tube, glasses being inserted in the sides through which it could be seen. A candle flame becomes at first brighter as the pressure increases, but soon smokes, the combustion being incomplete. In general, however, the author concludes that the temperature of combustion increases with the pressure.

Heumann has published in full his memoir on the theory of luminous flames, in which the results of an extended investigation are given. He maintains that there are three separate causes which may destroy the luminosity of gas—subtraction of heat, dilution of the gas, and oxidation of the illuminants. Those hydrocarbon flames which lose their luminosity by cooling them recover it again when they are heated. Those which lose it by dilution with air or with indifferent gases recover it by raising the temperature of the flame. Those flames which lose their brightness by the moderate introduction of oxygen, which oxidizes the carbon directly, are made bright again upon diluting the oxygen.

Champion and Pellet have called attention to the resemblances which exist between the mode of decomposition of explosive bodies and the phenomena of supersaturation. They mention many respects, for example, in which a supersaturated solution of sodium sulphate resembles, in its instability and the means by which it solidifies, the explosive dynamite.

Magnier de la Source has experimented upon the solubility of uric acid, and has discovered that the coefficient of solubility is a function not of the temperature at which it is determined, but of the maximum temperature which the mixture may have attained previously, and of the time which they have been in contact. Moreover, the solubility is also variable, since decomposition takes place. He concludes (1) that uric acid in solution has a variable solubility coefficient, which is the higher the more dilute the solution; (2) that this increase in solubility is due first to the production of a more soluble hydrate, and then to the dissociation of this hydrate into urea and dialuric acid; and (3) that this dissociation is facilitated by heat, especially in presence of potassium hydrate.

Weber has determined anew with great accuracy the specific heat of carbon, boron, and silicon by means of Bunsen's ice-calorimeter. If the specific heat of these bodies be taken at a temperature where they are constant, that of carbon is 0.467, silicon is 0.203, and boron is 0.500, thus bringing the atomic heats under the law of Dulong and Petit, as 5.6, 5.7, and 5.5 respectively. Three varieties of carbon were employed, their specific heat being the same at the temperature of 225°.

Schüller and Wartha have proposed some modifications in the ice-calorimeter of Bunsen, with a view of adapting it to more general use. The freshly fallen snow is replaced by ice, and the measurements are made by weighing the mercury expelled.

Naumann finds in the recent results of Kundt and Warburg upon the specific heat of mercury vapor a complete confirmation of the opinion which he, on purely theoretical grounds, expressed eight years ago, that mercury and cadmium molecules are diatomic. Moreover, he shows, in accordance with the dynamic theory of gases, that the heat of the atomic motion is to the heat of the molecular motion, and to the heat of expansion, as $n : 3 : 2$, in which n is the number of atoms in the molecule. The specific heats of gases, including that of mercury vapor, calculated on this hypothesis, agree well with those experimentally determined by Regnault and others.

Marié Davy has called attention to the agricultural value of meteorological observations. He gives the results of experiments made on growing wheat, in which the rate of transpiration was compared with the temperature and the actinometric power, and also gives statistics to show the connection between meteorology and crops. He believes that at the close of May or early in June, at which time the wheat is in flower, it is possible to deduce from purely meteorological data the value of the future crop.

Gernez has published in full his paper on the evaporation of superheated liquids. Having already shown that evaporation is the only normal mode of vaporization of liquids, he now considers the peculiarities of this mode of producing vapor.

OPTICS.

C. W. Siemens has exhibited at the Royal Institution some remarkable experiments on the action of light on the conductivity of crystallized selenium, mainly the results which had been obtained by Dr. Werner Siemens, of Berlin. He shows that cast selenium becomes more homogeneous and extraordinarily sensitive to light if it be kept for some time at or above 210° Centigrade. In this condition it may be used as a photometer, and is capable of giving accurate and constant results. Diffuse daylight doubles the conductivity, and direct sunlight increases it more than tenfold. A selenium "eye" was shown which had a selenium disk for the retina, and two slides for the eyelids. The eye was shown to be sensitive to white light, and also in different degrees to light of different colors. By means of an easily arranged electro-magnetic arrangement the current might be made to open and close the eyelids automatically, the selenium eye blinking by a flash of light exactly as does the natural one.

Lommel has given some ingenious and satisfactory demonstrations of certain optical problems not easily made evident without the higher mathematics, such, for example, as the angle of minimum deviation in prisms, achromatism, theory of the rainbow, etc.

Allard has investigated several questions of practical interest in light-house illumination, such as the transparency of flames and of the atmosphere, and the visibility of scintillating lights.

Rutherfurd has published a short account of his new glass circle for angle measurements. The circle is ten inches in diameter, and divided to ten minutes of arc. It is read by two micrometer microscopes magnifying seventy-five times. The probable error of a single reading is shown to be considerably less than half a second, while that of the mean of a series of such measurements is very much less. The author expresses his conviction that upon a fifteen-inch glass circle, provided with powerful microscopes, greater precision could be attained in the reading of angles than with the largest metallic circles now in use.

Krüss has studied the question of the depth of the images in optical instruments, and has given the results of the application of his principles to the human eye.

Abney has investigated the conditions of photographic irradiation —which causes the photographic image of a luminous body in front of a dark background to appear larger than it is—and concludes that the current theory that it is due to reflection from the back of the plate can only be true when the incident rays make an angle with the normal to the surface. This he conceives to be the fact, the particles of silver bromiodide scattered through the collodion film acting to reflect the light thus obliquely. The experimental results given accord well with those calculated on this theory.

Terquem and Trannin have described a new method for determining rapidly the index of refraction of a liquid, which, like Wollaston's, depends upon the angle of total reflection, but which does not require a special apparatus. By means of two plane parallel plates of glass, having a film of air between them, which are immersed in the liquid to be examined, the critical angle is determined, and so the index.

Hagenbach has called attention to the fact that unannealed or imperfectly annealed glass, which is in a state of tension from too rapid cooling, is very likely to break either from a blow or from sudden changes of temperature. As this tension renders the glass doubly refracting, he proposes to examine glass articles with polarized light in order to detect any imperfection in the annealing.

Gaumet has devised a new telemeter, or distance measurer, which is small enough to be carried in the pocket, and which gives the distances it measures to within one fiftieth of their actual value. Even this may be exceeded by using an observing telescope. It is founded on doubly reflecting the object from two mirrors placed at 45° from each other, one of which is movable. By means of a base-line, and the angle formed by the lines drawn from the distant object to the extremities of the base-line, the distance may be calculated.

Salet has investigated anew the question of spectra of different orders. He combats the view of Schuster that nitrogen ceases to give the characteristic channeled spectrum after being heated with sodium, and shows, first, that the spectrum in question can be obtained from nitrogen heated in contact with sodium; second, that the disappearance of this spectrum in the experiment is due to the disappearance of the nitrogen itself, it being absorbed by the sodium under the influence of the electric discharge; and, third, that the spectrum described by Schuster is really due to vapors of the alkali-metal.

Potier has examined mathematically the question of the influence which the motion of matter exerts upon luminous ether waves.

Salet has examined the spectrum of nitrogen and of the alkali metals in Geissler tubes. He observed that sodium sealed with nitrogen in a tube under a slight pressure did not always cause the disappearance of the bands in the nitrogen spectrum, but that it appeared even to absorb the nitrogen and to become black. This nitride, treated with water, gave the reactions of ammonia. In his opinion, therefore, the bands in the nitrogen spectrum are not changed when treated with sodium, unless the nitrogen is actually absorbed by the sodium, when the spectrum changes, of course, to that of sodium vapor, which was the spectrum supposed by Schuster to be that of nitrogen.

H. Vogel has published additional facts concerning the effect of certain coloring matters upon the sensitiveness of silver bromide to different portions of the spectrum. He finds, for example, that a dilute solution of methylrosaniline picrate increases powerfully this sensitiveness for the red rays between B and C. He says (1) that pure silver bromide is sensitive even to the ultra-red rays; (2) that to the substances already enumerated as increasing the sensitiveness of the bromide for special parts of the spectrum must be added methyl violet and cyanin, the latter increasing it for the orange rays; (3) that it is better to flow the alcoholic solution of the coloring matter on the collodion; and (4) that too strong a solution is to be avoided.

Vogel has also made an examination of the absorption spectra of several salts of the iron group of metals, and has drawn the characteristic absorption curves which belong to them, with a view to utilize the spectro-analytic method in qualitative analysis. By this means he has detected permanganate in a layer one and a half centimeters thick of a solution which contained only $\frac{1}{250000}$ part.

The same author has given the results of his examination of the spectra of various coloring matters, with especial reference to their use for detecting these substances when used for adulterations, especially in wines. These substances are very numerous, not less than 482 having been mentioned for this purpose at the recent Wine Congress in Colmar. Vogel uses a common pocket spectroscope, a few test tubes, and some simple reagents. Upon a horizontal line as the axis of abscissas he erects perpendiculars at the positions of the Fraunhofer lines, and then, by means of ordinates proportional to the intensity of color at different points, he obtains a simple intensity curve by which the results may be very readily compared. Figures of many of these curves are given in the paper.

Sauer has experimented upon the visibility of the ultra-violet rays of the spectrum. He used for this purpose light emitted by zinc in the electric arc, which he observed was particularly rich in these rays. He thinks there would be no great difficulty in using this method for obtaining a photograph of this portion of the spectrum.

Lockyer has made some remarkable observations on the spectrum of calcium at different temperatures and under different conditions. The blue line ordinarily observed in the calcium spectrum given with a Bunsen burner he considers a line of calcium itself, the other lines being those of its chloride, not dissociated. As the dissociation advances by rise of temperature, the blue line becomes more brilliant and the chloride spectrum fades. If now the electric arc be employed, the blue line is intense, and two new lines appear in the violet which occupy the position of the two H lines in the sun spectrum. But while in this spectrum the blue line is the most intense, the reverse is the case in the solar spectrum. Using, however, a large induction coil and battery, and then a small coil and battery, Lockyer found that while in the latter case (the spectra being photographed) the blue line only was apparent, in the former the violet lines appeared, with no trace of the blue one. Varying the intensity of the current, a fac-simile of the three lines in the sun spectrum was obtained. The author queries whether these facts do not teach the dissociation of calcium itself, and suggests solving the problem by photographing the H lines of stellar spectra.

Delachanal and Mermet have given some results obtained by means of their spectro-electric tube which show its value in qualitative analysis. In the ashes of the sporules of the common puff-ball (*Lycoperdon pratense*), after separation of the silica, lines of sodium, calcium, magnesium, zinc, copper, and hydrogen were observed. A specimen of zinc examined in this way showed the presence of both indium and gallium. The estimated amount of indium in ten kilogrammes of the zinc was 0.050 gramme, and of the gallium 0.002 gramme.

Berthelot has re-examined the question of the rotatory power of styrolene, which he had asserted, but which had been denied by Van't Hoff. He finds that the value of $(a^{n}) = -8.1°$ in one specimen and $-3.4°$ in another. The difference appears to be due to the presence of a little inactive styrolene.

Wunder has investigated the absorption spectra given by light reflected from different varieties of ultramarine, and gives curves showing the variation of intensity.

Mach and Merten have studied the effect of pressure upon quartz, and have shown that the velocity of light in the quartz may be changed by compression, the optical elasticity being lessened in the direction of the pressure, but much more in a direction perpendicular to this. Quartz may therefore be looked upon, say the authors, as an isotropic medium which has been subjected to an enormous pressure during crystallization, perpendicular to the axis, thus developing its double refraction.

Bosanquet has contrived a new form of polariscope, with which he has studied particularly the polarization of the sky. The essential part of the instrument consists of two quartz wedges, one of which is right-handed, the other left-handed. The terminal faces are cut at right angles to the axis, and the inclined common surface of the wedges makes an angle of about thirty degrees with the direction of the axis, which is also the line of vision. The quartz parallelopipedon is mounted in a tube having at the eye end a Nicol prism. The author claims for it certain advantages over the Savart polariscope, and gives some of the results he has obtained with it in studying the polarization of the sky.

Soret and Sarazin have made a series of measurements to ascertain the rotatory power of quartz upon ultra-violet light, in which they used very successfully the new fluorescent eye-piece for the spectroscope recently devised by Soret. They succeeded in measuring the rotation of rays as far as the line N, and found that it increased from 51.22 at H to 55.88 at L, 59.03 at M, and 64.41 at N. The theoretical values calculated from Boltzmann's formula agreed well with these. Subsequently Croullebois has stated that he had made similar measurements, extending as far as the line O.

Nipher has communicated to *Nature* some ingenious optical experiments, essentially physiological in character. Roll up a sheet of paper, look through it, with one eye focused on some object beyond. On placing the hand by the side of the distant end of the tube, it will seem as if the hand were perforated and the sides of the tube transparent. If a drop of ink be placed on the hand, it will appear in the inside of the tube, but the hand itself will be invisible. This tube arrangement, used with both eyes, is excellent for viewing complementary colors.

ELECTRICITY.

Sandoz has examined four of the new Jamin permanent magnets of laminated steel with a view to ascertain whether their force varied with time whether the armature was attached or not, and also whether sudden rupture diminished the portative force. The magnet employed weighed 411 grammes, and its armature 69 grammes. Its maximum lifting power was 9.3 kilogrammes, or nearly twenty-three times its own weight. He finds that these magnets gain rather than lose by time, and that whether they are kept armed or not; and sudden rupture rather increases their power to receive charges.

Camacho has described a new form of electro-magnet, in which, instead of a bar of iron, the core is made up of a number of concentric tubes of iron, around each of which a coil of wire is wound. In one experiment such a magnet, charged with the same battery, lifted five times the weight which was raised by a precisely similar magnet constructed on the old plan. In a subsequent paper Du Moncel has communicated to the Academy some results he obtained with this magnet, which are analogous to those made by him in 1862. He shows that the increased power obtained in these magnets is due to a superposition of the magnetic effects by the enveloping cores.

Jamin has re-observed and extended the curious fact stated by Haldat that iron filings, inclosed in a brass tube and compressed, retain their magnetism permanently. Tubes thus made were shown the Academy, eight or ten centimeters long and three in diameter, which attracted iron filings at least as strongly as steel bars of good quality of the same size. Filings of pure soft iron showed the same result, as also did iron reduced by hydrogen.

Jamin has published an extended paper on magnetism, in which he gives the laws of magnetic distribution.

Duter has studied the distribution of magnetism in circular and elliptic steel plates, and concludes, 1st, the free magnetism is proportional to the surfaces; 2d, it is distributed in hyperbolic lines, the non-transverse axes of which are in the direction of the axes of symmetry perpendicular to the neutral line.

Gaugain, in a paper on the processes of magnetization, has stated that when two magnets have their contrary poles placed in contact with a bar near one of its ends, their action to develop magnetism temporarily at the middle point of the bar is very unequal, while the permanent magnetism thus produced is stronger at this middle point when but a single magnet is used. He gives theoretical considerations in explanation of these phenomena.

Gaugain has also studied the influence of the temper of steel upon its magnetization. As a result of his experiments, he concludes that those bars which have received the hardest temper are those which take the strongest magnetization when powerful means are employed to develop it, but that annealed bars are magnetized more strongly by means which are less energetic.

Favé has experimented on the action of heat on the magnetism of steel bars, with special reference to the observation of Jamin that steel is capable of receiving a considerable magnetism at a temperature at which it loses entirely all magnetism which it has received when cold. He finds, 1st, that the magnetism of a bar may be preserved at any temperature whatever, if this temperature be maintained constant; 2d, that the diminution of the magnetism, at first slow, becomes very rapid at the end of a time varying with the temperature of magnetization; and, 3d, the magnetism which remains after cooling, increases again upon heating the magnet.

Cazin has sought to establish a relation between the heat produced by the magnetization and the demagnetization of iron, the amount of magnetism alternately lost or gained by the core and the position of the poles, and in this way to get an approximate value for the magnetic equivalent of heat.

Duchemin has proposed the use of nickel for the protection of the needles of marine compasses against rust, and he gives the results of some experiments in this direction, made with his circular compass, which were entirely satisfactory. The deposit of nickel does not seem to affect appreciably the magnetization.

Deprez has made some experiments on the velocity of magnetization and demagnetization of iron, and finds that soft iron, ordinary iron, malleable cast iron, and chilled steel all required one and a half thousandths of a second for magnetization, and one four-thousandth for demagnetization. Gray cast iron was magnetized in one thousandth.

Rowland has published the results of his studies on magnetic distribution, giving the results of experiments made in 1870–71.

Bleekrode has investigated somewhat exhaustively the question of the use of ebonite plates in electric induction machines in place of glass ones. He maintains that even in ordinary machines they are far preferable, but that in double machines, such as the one devised by him, they are the only kind to be used. Moreover, they have important theoretical advantages in addition.

Warren de la Rue and Muller have described the method of construction of their new intensity battery, consisting of 8240 cells. This battery is composed of plates of chloride of silver and of zinc, excited by a solution of sodium or ammonium chloride—a form devised by De la Rue in 1868. The electro-motive force of this combination is to that of the Daniell cell as 1.03 to 1; the mean resistance of the entire battery is for each cell 88.5 ohms. It evolves from acidulated water (1 volume sulphuric acid and 8 of water), in a voltameter having a resistance of 11 ohms, 214 cubic centimeters of mixed gases per minute. The length of the spark in air, given by one series of 1080 cells, was 0.098 millimeter; with two such series, 0.629 millimeter; and with three, 1.628 millimeters; being directly as the square of the number of the elements used. In a subsequent paper the luminous effects produced by this spark in vacuum tubes are described, the striking distance being six decimeters.

Von Waltenhofen has described a new form of magneto-electric machine recently constructed by Siemens and Halske. It consists of steel magnets for producing the field, the peculiarity of which consists in their form and arrangement, which is like two V's, thus ◇, in the space between which a Siemens-Alteneck armature revolves. The machine is easily turned by hand, and with one rotation a second gave the electro-motive force of three Bunsen cells, and with three rotations one of eight. It heated to whiteness 80 cm. of platinum wire ⅓ mm. thick, worked an induction coil, decomposed water, etc. Tisley has also devised an improvement in the break-piece of the Siemens armature, by which the effects are increased.

Tresca has given the results of some experiments with the Gramme machine, made with great care to determine the economic value of this machine for the production of light. Two machines were employed, one of about six times the power of the other. The number of candle-powers obtained from the first was 12,950; the consumption of power, 7.68 horse-powers, or 1686 candles to the horse-power. From the second and smaller machine the light was equal to 2114 candles; and the power consumed was equal to 2.81 horse-powers, being 752 candles to the horse-power, thus showing the greater economy of the larger machine. The cost of the illumination by the larger machine was only one hundredth of that of the same light when obtained with oil, and only one fiftieth of that obtained with coal gas.

Some experiments have been made in Paris upon dividing the electric light, under the direction of M. Baron. A single Gramme machine has fed in this way not less than eighteen lamps, each of which gave a light equal to 100 gas jets.

Mouton has proposed a simplified method of determining the internal resistance of a battery without complicated apparatus and the sacrifice of much time. It gives the resistance in terms of that of a certain shunt wire introduced into the circuit.

Planté has continued his experiments with secondary batteries, and now shows that the spark taken from the surface of water gives phenomena analogous to those observed in polar auroras.

Bourbouze has proposed to use natural conductors, such as watercourses, and even the earth, as a medium through which to obtain electric signals. Experiments which he has made in Paris seem to have been quite successful.

Girouard has described a new form of regulator for the electric light, the essential point of which is the use of a balanced arm separate from the carbon holder, and acting as a relay, through the magnet of which the whole current passes. The current of a small battery contained in its base is sent in one direction or the other, according as the electro-magnet is weak or strong, and this determines the motion of the clock-work by which the carbon points are separated or brought together. This balanced regulator has been used in the United States for many years by Farmer.

Holtz has described a new form of tube for electrical illumination, which is an improvement upon the one devised by Gaugain, in which a series of funnels directs the discharge. In the new tube there are one, two, or three diaphragms, in each of which are two funnel tubes facing opposite ways, those facing each way being on a right line parallel to the axis of the tube. The effect is the same as in Gaugain's tube, but the single tube is much more convenient.

Oberbeck has given a new method of measuring the electric conductivity of liquids. It consists in measuring the maximum striking distance between two balls of a given induction spark, and then introducing as a lateral circuit the liquid to be measured, and again measuring the spark. By making a series of observations and plotting them, taking the lengths of the liquid columns as abscissas and the spark length as ordinates, a curve of conductivities is very readily obtained.

Rowland has called attention to an error in Kohlrausch's determination of the absolute value of the Siemens mercury unit of electrical resistance, which he thinks will account for the two per cent. difference from the results of the British Association committee. This error consists principally in the omission from his equations of the coefficient of self-induction. Stoletow, in a subsequent note, while admitting that the error exists, and that its correction will tend to approximate the results, clearly shows that the error is entirely too small to extinguish the two per cent.

Wilson has contrived an ingenious method of attaching a mirror to a galvanometer needle so that the angular motion of the beam of light reflected from it shall be the same as that of the needle. For this purpose the light passes vertically upward to the mirror, which is fastened directly below the needle, and at an angle of 45° to its plane of oscillation.

Edlund has observed a fact of great importance to his theory of electricity, *i. e.*, the fact that the resistance of a conductor varies with the motion of this conductor, being lessened when the conductor and the current move in the same direction, and increased when the directions of the motion are opposite. In Edlund's theory, in which electricity is only the flow of ether through bodies, the strength of the current is measured by the mass of the ether which flows through the cross-section of the conductor in a unit of time.

Fuchs has proposed to use the electrometer as an instrument for measuring current strength, polarization, and resistance. In his experiments he employed a gold-leaf electrometer in communication with a dry pile. By combining this with the compensation method of Poggendorff, the results were satisfactory.

Fleming has made additional experiments to prove the position assumed in his paper read at the British Association and objected to by Rowland, *i. e.*, that the electro-motive force developed by the motion of an electrolyte through a strong magnetic field effects the decomposition of this electrolyte. He now shows that the facility of polarization of the plates is unaffected by the aeration of the liquid, and that the cause of this polarization can be removed from the plates mechanically.

Becquerel has published an important paper on the determination of the chemical force exerted by two solutions upon each other by means of the electro-motive force developed. The method is suggestive, especially in its physiological relations, since the strength and direction of the electro-motive forces in living beings are the foundations upon which rest not only all the phenomena of nutrition, but also those of life itself.

Dufet has experimented upon the electric conductivity of pyrite. He finds that this constant is very variable with different specimens, owing, undoubtedly, to want of homogeneity in them. While crystals from Traversella had a resistance varying from 750 to 4000 times that of mercury, those from Deville, more homogeneous, had a resistance only seventy-five times that of this metal. The results obtained show also that in a given crystal the resistance is constant and independent of the direction, duration, or strength of the current.

Oberbeck has experimentally determined the resistance which the air offers to an induction spark. He shows that it is a function of the strength of the currents, and that hence its numerical value may be calculated in the same way as that of solid or liquid conductors.

Bauermann communicates a method of showing the conductivity of the various forms of carbon, due to Dr. Von Kobell, of Munich. A fragment of the carbon to be tested is held in a pair of zinc tongs (a simple strip bent on itself) and immersed in copper sulphate solution. The proportion of copper deposited on the carbon indicates its conducting power.

Lippman notes the curious experiment of putting a mass of water contained in a glass vessel in communication with the earth, and then bringing near it an excited rod of resin; oxygen is evolved at the wire. On removing it the hydrogen is disengaged. But before removing the rod, where was the hydrogen? The author says it is neither in combination nor solution, but is retained upon the surface of the water.

Buff has made an extended investigation into the changes of temperature which are produced when an electric current passes from one metal to another. The evolution of heat is proportional to the quantity of electricity passing in a unit of time multiplied by the electro-motive force of the battery.

Lovering has proposed an ingenious method of determining the velocity of electricity by means of two electro-magnetic forks vibrating at right angles and giving Lissajous' curves. If known resistances be introduced in the circuit of one of the forks, the change in phase will indicate the retardation of the current and give the data for the calculation.

Deprez has contrived a new form of electro-magnetic register for recording velocities. With the apparatus figured, which is simple in its construction, 600 complete signals can be recorded in a second.

Bichat has published an interesting memoir upon induction, in which he shows that as a current of high electro-motive force may be developed from one of low by means of the so-called induction coil, so, by passing a current of high tension from a Holtz machine through the outer coil, a current is generated in the inner coil capable of producing magnetic effects and of decomposing water, precisely as does the direct current from a battery. He also suggests an important modification in the Foucault interrupter, by which the intermittent current is interrupted more uniformly.

Weber has communicated an extended paper on the theory of the galvanometer, in which he discusses the whole subject mathematically.

Bunsen has given some results obtained in his laboratory by Hillebrand and Norton on the electrolytic preparation of the metals contained in the mineral cerite. About forty grammes of the elements cerium, lanthanum, and didymium were obtained in this way.

Kerr has been led from theoretical considerations to the discovery of a new relation between electricity and light. He has proved that dielectrified media are doubly refractive during the charge. The media employed were glass, resin, and quartz. The results prove that dielectrified resin acts as if extended along the lines of force, while dielectrified glass and quartz act upon the transmitted light as if they were compressed along the lines of force.

Colladon has published an extended research on the effect of lightning on trees, in which he gives the results of investigations on poplars, oaks, elms, pears, firs, grape-vines, chestnuts, and walnuts. The conductivity of poplar, he observes, is such as to make it of service as a lightning-rod, and he recommends connecting the base of these and of other tall trees with permanently moist earth—if possible a watercourse—by means of a metallic rod.

Schaack has given in a recent memoir his views upon the construction of lightning-arresters at present used for telegraph lines. He proposes to replace these by a simple trough of water, made of metal and connected to earth, through which the wire (a fine spiral of silk-wound German-silver wire covered with a thin coating of rubber) which connects the register with the line passes. The earth connection from the register is made to the metal of this trough. A discharge of lightning would melt the small wire and escape to earth, leaving the instruments uninjured.

CHEMISTRY.

By GEORGE F. BARKER,

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In *General Chemistry*, Cayley has communicated to the Chemical Section of the British Association a paper on the analytical figures which are called trees in mathematics, and on their application to the theory of chemical compounds. His purpose was to determine the theoretical number of hydrocarbons of the formula C_nH_{2n+2}, and his results agree with those of experiment so far as the latter have been developed. He shows, for example, that 799 isomers are possible, having the formula $C_{13}H_{28}$.

Berthelot has continued his studies in thermo-chemistry, and has published two papers. In the first of these he treats of the thermal changes connected with the oxides of nitrogen; in the second, of the thermic formation of barium dioxide and hydrogen dioxide.

Muir has given his views of the present system of chemical notation and its complete significance, arguing that its symbols actually do mean far more than they are usually made to in ordinary usage, and hence that the newer dynamical views now arising may find it best to retain them.

Janovsky has published a paper on equivalence, in which he maintains with good reason that the only rational basis for this property of atoms, as well as for the correlative one of combining weight, is to be found in the dynamical theory of work.

During the month of April a national chemical society, with the title of the American Chemical Society, was organized in New York. The objects of this body are the encouragement and advancement of chemistry in all its branches, in furtherance of which monthly meetings will be held in New York, and an annual meeting at some selected place. The society starts with a membership of 133, under the presidency of Professor J. W. Draper.

Mills has published an important paper on "The First Principles of Chemistry," in which he places in a strong light the dynamic theory of chemistry in distinction from the statical theory now generally received.

Lodge has given an interesting discussion on nodes and loops in connection with chemical formulas, showing that the number of each may be easily calculated in any given case.

Ostwald has experimented to determine the effect of mass in the chemical action of water upon other bodies. He used a solution of bismuth chloride, to which various quantities of water were added, the amount being in all cases more than enough to produce the precipitate. These precipitates were analyzed, and the ratios of the chlorine and bismuth determined. From them a curve was constructed, which is hyperbolic along two thirds, and straight for the other third of its length. Hence the author believes Bertholiet's law is true, the action being proportional to the mass, the curve being due to external influences.

INORGANIC CHEMISTRY.

Pierre and Puchot have obtained a crystallized hydrate of hydrochloric acid by cooling a saturated solution of the gas in water to —21° or —22° Centigrade, a current of this gas being maintained through it. As soon as crystallization begins, the temperature rises to —18°, and remains there so long as crystals form. Synthetical calculation as well as analysis fixed the formula of the crystals as $HCl(H_2O)_2$. The authors hence recommend a mixture of hydrochloric acid and snow as a freezing mixture.

Berthelot has studied the thermic conditions attending the formation of ozone. He finds that in the production of one molecule of ozone from oxygen there is an absorption of 29.6 calories. Being therefore a body formed with the absorption of heat, its activity chemically is accounted for; it is a magazine of energy stored up under the influence of electricity.

Frankland has published a paper on water analysis, in which he examines the value of the albuminoid-ammonia process, and concludes that it is "entirely useless in the examination of waters for sanitary purposes." He claims, however, for the combustion process, that it is the only one which gives trustworthy information concerning the organic matter present, the only one which can determine the carbon, and the only one which shows the ratio of nitrogen and carbon.

Gladstone and Tribe have shown that water may be decomposed by the joint action of aluminum and aluminum iodide, bromide, or chloride. They suggest as probable that the reaction takes place in two stages. In the first the aluminum of the iodide is oxidized, and in the second it is regenerated, setting free hydrogen.

Precht and Kraut have published the results of experiments made to test the statement of Debray that the tension of aqueous vapor which is given by a salt containing crystal-water in a vacuum is dependent solely upon the temperature, and hence that this tension may be made use of to ascertain whether all the molecules of this water of crystallization are held with equal force. Their conclusion is that while in individual cases this may be done, it can only be considered reliable when all the collateral circumstances are taken into the account.

Weber has discovered a new compound of sulphur and oxygen, which has the formula S_2O_3, and which he calls sulphur sesquioxide or dithionic oxide. It is prepared by acting on sulphuric oxide, containing a trace of sulphuric acid, with sulphur. A dark blue compound separates in liquid drops, falls to the bottom, and solidifies in crystalline crusts. Below 15° Centigrade it is sufficiently permanent to be weighed. Selenium forms a similar compound, containing both oxygen and sulphur.

Behrend has described a new method of preparing sulphuryl chloride, which consists in heating sulphuric chlorhydrin in sealed tubes to 170°-180° for ten to fourteen hours. The yield is satisfactory.

Scheurer-Kestner has examined the gas which is produced by the combustion of pyrite, in reply to Bode. The sulphurous oxide varies from 6 to 9 per cent., the oxygen from 6 to 9 per cent., and the nitrogen from 84 to 85.5 per cent.

Olivier has given an elaborate paper descriptive of the sodium nitrate regions of South America, illustrated with an excellent map of the region.

Friedburg has proposed the use of fuming nitric acid for removing the last traces of impurity from carbon disulphide. The two are distilled together; the distillate is washed and rectified.

Nilson has made an elaborate investigation of the arsenic sulphides, by which he has thrown much light on the modes of formation and the reactions of these bodies.

Champion and Pellet have investigated the conditions of the decomposition of nitrogen iodide and chloride. Since both chlorine and bromine displace iodine from its combinations, it is natural to infer that these bodies will decompose nitrogen iodide. It is decomposed with explosion when placed at the end of a tube in which chlorine is being evolved, or in the vicinity of a rod moistened with bromine. The temperature at which the iodide detonates is 48° Centigrade. Notwithstanding Abel's opinion of its inconstant composition, the authors believe it to be uniform when made by placing one gramme iodine in 10 c. c. ammonia, agitating, allowing to stand ten minutes, filtering off, washing twice with 10 c. c. ammonia, and then with water. It is placed on gelatin paper, and covered with goldbeater's skin gummed down while still moist. On drying, the skin contracts and holds it fast. As to the chloride, the authors attribute its explosion in contact with turpentine to the attraction which this oil has for chlorine, and the ease with which it gives up its hydrogen. This view is strengthened by the fact that, when saturated with chlorine, the turpentine does not explode the chloride.

Acworth has examined the action of nitric acid upon copper, mercury, silver, etc., with a view to determine the gaseous products. He finds (*a*) that copper acted on by cold dilute nitric acid evolves a gas containing ninety to ninety-five per cent. nitrogen dioxide; (*b*) the same action in presence of a strong solution of copper nitrate evolves a gas containing eighty-five per cent. nitrogen monoxide; (*c*) potassic nitrate has no influence, but ammonium nitrate causes the evolution of nitrogen and nitrogen monoxide, with some dioxide; (*d*) mercury, zinc, and iron, in presence of ammonium nitrate, give rise to the evolution of nearly pure nitrogen; (*e*) silver alone with nitric acid gives chiefly nitrogen dioxide and nitrogen. With ammonium nitrate the gas evolved is chiefly nitrogen.

Storer has called attention to the almost universal occurrence of minute quantities of ammonia in the ordinary chemicals of commerce, the sulphuric acid examined affording from 0.07 to 0.16 of a milligramme in five cubic centimeters.

Meusel has proposed to account for the occurrence of nitrites in spring waters, not as is usually the case by supposing the oxidation of ammonia therein, but by supposing the reduction of the nitrates in the water through the agency of bacteria. He shows (1) that spring waters which contained bacteria and nitrates, but no ammonia or nitrites, showed the nitrous acid reaction on standing four days; (2) that the production of nitrites in this way is stopped by antiseptics; (3) that aqueduct water containing nitrates produces no nitrites, even in presence of bacteria, unless a carbohydrate be present; (4) that distilled water containing both glucose and nitrates can not be made to generate nitrites if bacteria be absent; and (5) that decomposing albuminates reduce nitrates to nitrites.

Spirgatis has given some facts which appear to prove the existence of arsenic in antique bronzes. Four bronzes were analyzed, two of them earlier than the Christian era, the other two of the fourteenth and fifteenth centuries. Of the earlier ones one contained 0.12 and the other 3.52 per cent. of arsenic; of the later the quantities were 0.96 and 0.32 per cent. respectively.

Gautier has given an improved method of quantitative testing for arsenic in cases of poisoning. The organic matter is destroyed by alternate treatment with strong nitric and strong sulphuric acids, the sulphide precipitated as usual, converted into oxide, and placed in a modified form of Marsh apparatus, by which the whole is collected in a tube and weighed.

Jones has made a somewhat extensive research on stibine, with a view to determine its exact composition. Taking the fact, discovered in the progress of the work, that stibine passed over sulphur is decomposed, yielding antimony sulphide and hydrogen sulphide, as the basis of a quantitative method, he proves this stibine to be SbH_3.

Suilliot finds that borax is not the excellent antiseptic that has been claimed, though it is equal in this regard to salt. But he gives the results of some experiments with calcium borate, which seem to show that this salt has antiseptic powers of considerable value. He believes that by the action of the meat the salt is decomposed, yielding a simple borate, which preserves from decomposition, while the boric acid thus set free preserves it from mould.

Troost and Hautefeuille have observed that when boron chloride is passed through a heated porcelain tube, silicon chloride and aluminum chloride are formed. Even pure silica and pure alumina are thus attacked. Silicon chloride does not attack porcelain, but is decomposed by alumina. Both chlorides attack zirconia and titanic oxide readily.

Hornberger has attempted to introduce zirconia into organic compounds, and has studied this earth at length. He concludes, first, that the similarity with silicon which is so striking in inorganic chemistry does not hold in organic; since, second, zirconia can not unite with alcohol radicals to form a sort of ether in which it plays the part of an acid; and, third, zirconia plays a decidedly positive part in organic compounds, this element replacing readily only acid hydrogen.

Moride has given some statistics of the production of charcoal from algæ on the French coast, which has risen to an important industry; 100,000 kilogrammes of the fresh plants yield 20,000 kilogrammes of the dried, and 5000 kilogrammes of charcoal. This, when incinerated, yields from 3500 to 4000 kilogrammes of saline matter, containing 20 per cent. of potassium salts. The charcoal itself is an excellent disinfectant and decolorizer, and is also used as a fertilizer.

Hartley has examined the liquid which is contained in the cavities of some varieties of rock-crystal, and comes to the conclusion that it is liquid carbon dioxide. Comparing his results with Brewster's, he adds to the list several other minerals. The proof of the fact stated he finds in the fact that the critical point for the inclosed liquid is between 30.75° and 31° Centigrade, while that of liquid carbon dioxide, as determined with great care by Andrews, is 30.92°.

Wright has examined several more meteorites for the purpose of determining their gaseous constituents, and finds essentially the same composition for these gases as that given by the Iowa meteorite before published. The present results, however, were obtained at temperatures varying from 350° Centigrade to a full red heat for the stony, and from 500° to a bright red heat for the iron meteorites. His previous generalization, that stony meteorites differ from iron ones in containing more carbon dioxide and less hydrogen and carbon monoxide, and in evolving their gaseous constituents at a much lower temperature, seems fully confirmed.

In a later paper Wright continues his studies upon the gases contained in meteorites, and gives the results of his examination of the Kold Bokkeveld meteorite, which, though stony, contains considerable carbon and some bituminous matters. It yielded 25.23 volumes of gas, of which 93.11 per cent. was carbon dioxide, the remainder being carbon monoxide, marsh gas, hydrogen, and nitrogen, the two latter in minute quantity. It also yielded ten per cent. of water, in which chlorine and sulphurous oxide were detected. The question of the manner of occurrence of the gases within the meteorite is also discussed.

Remsen and Southworth have made the curious observation that carbon monoxide is not oxidized by ozone. The two were passed into a flask, and then through lime-water; but not a trace of turbidity was perceptible in the latter, even when the entire apparatus was placed in full sunlight. The authors discuss the bearing of this fact upon the question of free attractions in carbon monoxide.

Zöller has made a series of experiments upon the antiseptic and disinfecting properties of carbon disulphide, from which it appears that this substance is quite remarkable in this direction. Since it appears that mould and putrefaction can not take place in air containing a comparatively small quantity of this vapor, the author especially recommends such an atmosphere for preserving meat and other food during the process of transportation to the consumer.

Houzeau has given a new method for the volumetric determination of free carbonic acid, which consists in absorbing the gas in a titered solution of sodium hydrate, precipitating the carbonate in an insoluble form by a neutral solution of barium chloride, and then titering back with a graduated solution of sulphuric acid. To prevent the formation of sodium bicarbonate a small quantity of zinc oxide is dissolved in the soda solution before use.

Bong has described a new class of prussiates, obtained from the yellow prussiates in much the same way as the nitroprussiates, but using chloric acid in place of nitric. The potassium salt is black when solid. It dissolves readily in water, giving to it an intense violet color, but is almost insoluble in alcohol. With metallic salts, even with those of zinc, it gives dull green precipitates, more or less dark —a fact which distinguishes the new salt from the ferricyanide.

Godeffroy has redetermined with care the atomic weights of rubidium and cæsium. The metals were separated from each other and from potassium by crystallization as alums, the last traces of rubidium being removed from the cæsium salt by precipitation of the latter by means of antimonous chloride. As a mean of four closely accordant determinations, the atomic weight of cæsium obtained was 132.627, and that of rubidium 84.525.

The ammonia-soda process of Solvay has, according to German accounts, been lately so much improved as to threaten the abandonment of the standard method in Germany.

Guyard has examined the residue left in the retort after the manufacture of sodium. The mixture put in consisted of crude salt of soda, 56.5; coal, 18.5; coke, 10.5; chalk, 14.5. The residue, after exposure to the air, consisted of 35 per cent. of soluble matter, 9 of water, 22 of carbon, 18 of carbonate and oxysulphide of calcium, ashes and iron oxide, 15.4. The soluble portion contained 11.9 caustic soda, 44.30 carbonate, 24.10 sulphate, 11.70 sulphite, 0.45 sulphide, 7.05 chloride of sodium, 0.2 silica, 0.3 of alumina, and traces of lime and potash.

Terreil has analyzed the black residue obtained by calcining potassium ferrocyanide, and finds it to consist of metallic iron, 32.05; magnetic oxide of iron, 27.56; uncombined carbon, 27.49; combined carbon, 1.17; carbon as cyanogen, 0.24; potassium, 0.81; nitrogen, 0.29; oxygen, 10.50.

Grünzweig and Hoffmann have conclusively sustained their statement of the crystalline character of ultramarine, against Büchner, who had maintained that the crystals observed under the microscope were those of quartz. They now bring forward the testimony of additional experts, who have seen and examined the crystals, and of Vogelsang, who has determined them to belong to the cubic system.

Gladstone has observed that the chemical activity of aluminum is greatly augmented by contact with a more negative metal, this substance decomposing water readily at 100° Centigrade when either copper or platinum was electrically deposited upon it. In connection with Tribe, Gladstone has also made some experiments upon the activity of pure zinc, as compared with zinc upon the surface of which copper has been deposited. From this it appears that even arsenical zinc, when covered with copper, may be boiled with water, and evolve large quantities of hydrogen without giving in this gas a trace of arsenic. The foil alone, treated with dilute sulphuric acid, gave abundance of arsenous hydride.

Gladstone and Tribe have also extended their researches to the decomposition of aluminum in presence of its haloid compounds, and have observed that alcohol is readily decomposed on heating with this metal and its iodide, evolving hydrogen and leaving aluminic ethylate in the retort. This latter body is a yellowish-white solid, which is capable of distillation.

Naumann shows that potassium-alum solutions, when heated to 100° Centigrade, are partially decomposed, losing a portion of their sulphuric acid.

Troost and Hautefeuille have described a manganese boride, and have studied elaborately the part which manganese plays in the metallurgy of iron, paying especial attention to the thermo-chemical reactions involved.

Parsons has made a series of experiments at the Woolwich Foundry on a manganese bronze, which, when forged, had a strength of twenty-nine tons to the square inch, an elastic limit of twelve tons, and an elongation of nearly thirty-two per cent.

Laspeyres has investigated the chemical constitution of the natural and artificial oxides of manganese, called braunsteins, with a view to determine the equivalence of the metal manganese.

Mermet has proposed a very delicate test for the so-called sulphocarbonates, now coming into extended use among grape-culturists as remedies for the phylloxera. If to an extremely dilute solution of a salt of nickel in ammonia a few drops of the solution to be tested be added, a characteristic currant-red color is developed. This test is extremely delicate, showing $\frac{1}{60000}$ or even $\frac{1}{80000}$ of sulpho-carbonate in a solution. Braun had proposed some time before the sulphocarbonate as a very delicate test for the presence of nickel.

Lecoq de Boisbaudran, the discoverer of the new element gallium, has given laboratory methods for the extraction of this metal from the blendes in which it occurs. A list of blendes is given, together with their relative values as sources of gallium. The best one is that called the black blende of Bensberg.

He has subsequently communicated additional facts concerning his new metal, gallium. He has prepared the metal itself electrolytically, and a piece of it weighing 3.4 milligrammes was presented to the Academy by M. Wurtz. The spectrum consists of only the two lines already mentioned, of wave lengths 417 and 403.2 respectively. He has succeeded finally in obtaining a grain and a half of the metal in the pure state, and has determined that it melts at 85.1° Fahr., so that it liquefies when held in the hand. Its specific gravity is 4.7, water being 1.

Guyard has thrown considerable light on the formation of aniline black by the discovery that the salts of vanadium have a marked influence in producing it. This he attributes to the facility with which this metal passes from one state of oxidation to another.

Bedson has made a series of experiments on compounds formed by the union of ether with certain chlorides of the metals. He has succeeded in forming such compounds with vanadium oxychloride and with titanium tetrachloride. Titanium trichlorhydrin is also formed.

Aronheim has suggested the use of molybdenum pentachloride as a most efficient chlorine carrier. While endeavoring to find a solvent for this substance, the fact appeared that even benzene when heated, after dissolving this body, evolved torrents of hydrochloric-acid gas. Further experiment proved its great superiority to iodine in this respect, because (1) it is more energetic and rapid, (2) carries the chlorinating more uniformly from one stage to the next, and (3) can be removed, after the reaction is finished, much more easily.

Terreil has communicated to the French Chemical Society the analysis of the magnetic platinum of Nischne-Tagilsk. The magnetic metals present are iron (8.18 per cent.) and nickel (0.75 per cent.). There is also given in the analysis 3.18 per cent. chrome iron.

De Souza has made a series of experiments to ascertain whether amalgams are actually chemical compounds. He maintained both silver and gold amalgams at the temperature of boiling sulphur until the weight remained constant, and then found that the former contained its constituents in quantities required by the formula $Ag_{13}Hg$, and the latter, Au_8Hg, thus confirming the theory of chemical union.

E. Dumas has written upon the touch-stone, giving an extended historical sketch of the subject, and furnishing an analysis of a stone which has been used from very ancient times in the Paris assay office. It proved to be a piece of fossil wood, of an unknown genus and species, however, to which, on microscopic data, Renault assigns the generic name *Obrussaxylon*, meaning wood used for assaying gold.

Sainte-Claire Deville and Debray have published some data concerning the density of pure platinum and pure iridium prepared with great care, and also that of several alloys of these metals. They find that the mean density of platinum, estimated from ingots weighing from 200 to 250 grammes, is 21.5. Iridium in the ingot has a density of 22.239; after breaking under the rolls, of 23.421. An alloy of 10 per cent. iridium has a density of 21.615; of 15, 21.618; of 33.33, 21.874; of 95, 22.384.

Scheurer-Kestner has communicated additional facts upon the corrosion of platinum stills which are used for the concentration of sulphuric acid. He finds (1) that the loss is not mechanical but chemical, the metal being contained in the acid in solution; (2) that when the acid is free from nitrous compounds, it dissolves about one gramme of platinum for every ton of sulphuric acid concentrated to 93–94 per cent., but six to seven grammes per ton when the concentration is pushed to 98° and above, rising even to nine grammes when the acid marks 99½ per cent.; (3) that the loss is even more considerable if nitrous products are present in the acid.

Boussingault has published a memoir upon the silicification of platinum and some other metals, showing that they do not unite with carbon at a red heat, that carbon reduces silicon at a high temperature, that platinum heated to whiteness in a silicious carbon crucible is silicified, and that the silicon is held by the carbonous oxide.

E. von Meyer has studied at length the apparent action of chemical attractions called into play during the slow oxidation of hydrogen and carbonous oxide by means of platinum.

Deville and Debray have observed that cyanide of potassium mixed with spongy platinum, and heated to 500° or 600° Centigrade in presence of aqueous vapor, evolves hydrogen, and forms potassio-platinum cyanide. The same is true of a concentrated solution of the cyanide. The authors show that this result flows necessarily from the thermal exchanges involved in the reaction.

Zarawkowitch proposes the use of glycerin for reducing platinum solutions in order to form platinum black; 15 c. c. of glycerin of specific gravity 25° to 27° Baumé, and 10 c. c. potassium hydrate of density 1.08, are gently heated, and 3 to 5 c. c. of platinic chloride is added. The platinum black falls, and is collected and washed.

Meyer has described a lecture experiment for illustrating that vaporization without fusion is due to pressure. Two glass tubes containing iodine are prepared and sealed, one vacuous, the other at nearly the ordinary pressure. If now both tubes be warmed, the iodine in the second tube melts, and may be made to run down the walls of the tube; in the vacuous tube the iodine only volatilizes.

Landauer has proposed a very simple form of blow-pipe, which consists simply of two bottles tubulated at bottom, and connected by these tubulures through a rubber tube. The upper opening of one of these is closed by a cork, through which a tube passes going to the jet. This bottle being empty, the other bottle is filled with water and placed at a convenient height. The hydrostatic pressure forces the air out of the first and lower bottle through the jet.

Frerichs has devised a new form of balance, in which the beam is made of aluminum alloyed with five per cent. of silver. The beam is very short, and yet the balance is not at all deficient in delicacy. The use of riders is dispensed with, the small weights being determined by the torsion of a wire ingeniously arranged.

Arzberger proposes the use of an air-damping apparatus for chemical balances, to diminish their oscillations. To the stirrup a gilded brass plate is hung, which moves in a short cylinder, a trifle larger in diameter, supported on the case.

Drechsel has described a new form of wash-bottle, differing from the older forms by having the tubes ground into the neck of the flask, the delivery tube being enlarged for this purpose, while up through the top of this enlarged stopper comes the inlet tube. For washing with corrosive substances it may be useful.

Mohr has communicated a paper on the nature and origin of meteorites, in which he discusses at length the chemical and astronomical questions involved.

Houzeau has proposed a method for the volumetric determination of carbon dioxide, depending on the absorption of the gas by a graduated solution of alkali, precipitation by barium chloride, and estimation of the free alkali.

Dupré has proposed a modification in Dumas' method for the determination of nitrogen in organic analysis, which consists in a carbonic-gas apparatus by which the air and the nitrogen may be removed, and a peculiarly constructed cylinder for receiving and measuring the gas.

Johnson has observed the formation of nitrites in the potash bulbs when bodies containing nitrogen are burned, and as these absorb oxygen and increase in weight, they may cause an error.

Precht and Kraut have investigated at length the question of the dissociation of salts which contain water, and have obtained some valuable results.

Langley has proposed, in determining carbon in iron and steel, to burn the carbon without first separating it from the copper, as is the usual method.

A new test-paper, prepared by Waller, is made by soaking strips of unsized paper in a solution of corallin, and is said to be exceedingly sensitive to the presence of alkalies, turning a beautiful red color, while acids turn it yellow. Waller proposes it as an alkaline reagent in place of litmus.

ORGANIC CHEMISTRY.

In *Organic Chemistry*, Fittig's hypothesis that cumene was isopropylbenzene has been established by Jacobsen, who has succeeded in effecting its synthesis by acting with sodium on isopropyl iodide, resting upon which was an equivalent quantity of brombenzene dissolved in six times its volume of ether. The action proceeded slowly, and after four days was interrupted. On fractionating, a hydrocarbon boiling near 150° was obtained, which had all the properties of cumene.

Pinner has re-examined more carefully the new hydrocarbon which he announced to have the composition C_3H_2, and finds that this is wrong, owing to an error in the formula of dichlorallylene from which it came. Its true formula is C_3H_4, and it is hence either allylene itself or an isomer of it.

Butlerow has shown that the olefines, like the terpenes, are capable of direct union with water to form alcohols, isobutylene yielding trimethylcarbinol quite readily in this way.

De la Harpe and Van Dorp have examined the hydrocarbon fluorene discovered by Berthelot. They find that when fluorene is distilled over moderately heated lead oxide a semi-solid reddish product is obtained, which is a condensation product containing double the number of carbon atoms in its molecule.

Osipoff has succeeded in preparing amyl alcohols from the direct union of amylene and sulphuric acid. The two forms of the alcohol obtained are respectively dimethyl-ethylcarbinol and methyl-isopropylcarbinol, the quantities varying according to the concentration of the acid used.

Dr. Van Hamel Roos has examined carefully the condition under which glycerin crystallizes, having had fifty-six pounds of crystals to work with. The crystals are monoclinic. The only requisite in their production is the freedom of the glycerin from water. Crystals are the best test of purity, and also the best means of purification.

Renard has studied the action of electrolytic oxygen on glycerin, and finds that there is produced a glyceric aldehyde, which reduces ammonio-silver nitrate, giving a brilliant mirror and also the copper test.

Girard has proposed to mix with dynamites, in order to prevent their congelation in cold weather—a result which seriously interferes with their explosive power—about ten per cent. of methyl nitrate. The volatility of this body he finds to be no inconvenience in practice.

Michaelis has succeeded in introducing arsenic into the aromatic series by acting upon arsenous chloride with mercury-diphenyl. A heavy, colorless, strongly refracting liquid was obtained, which was phenyl-arsenous chloride.

Sadtler has discovered the interesting fact that tartronic acid is a product of the direct oxidation of glycerine by nitric acid.

Kilmenko has studied the action of bromine on lactic acid, and finds that it yields ethyl bromide and a crystallized substance neutral in its reaction, and containing bromine, apparently formed by the direct union of bromal and lactide.

Kolbe has published a valuable paper entitled "Chemical Hints for the Practical Use of Salicylic Acid," of the synthesis of which substance he is the discoverer, and which has proved so efficacious as an antiseptic.

Bremer and Van't Hoff have examined the succinic acid obtained from active tartaric acid with a view to determine its optical action. According to the latter's view, no substance can rotate a polarized ray which does not contain one or more asymmetrical carbon atoms. Since succinic acid contains no such atom, it should not rotate such a ray; and the authors show that it does not.

Kupferberg has succeeded in effecting the retransformation of paraoxybenzoic acid into salicylic by heating its sodium salt to 290° Centigrade. Over one half of the theoretical yield was obtained.

Brunner and Brandenburg have succeeded in detecting succinic acid in the juice of unripe grapes. They were led to examine for it by the fact that nascent hydrogen, acting on ethyl oxalate, produced tartaric acid and glycolic acid. The same reduction process, the authors believe, therefore goes on in the plant.

Barth has investigated a product of the action of hydrochloric acid on resorcin observed by him some time ago. He finds it to be soluble in alkalies, and precipitable by acids in bright brown flocks, which on drying show a magnificent green metallic lustre, and by transmitted light are scarlet. It is an ether of resorcin.

Bindschedler and Busch have described the synthetic process by which the new red color, eosin, is produced artificially. As is well known, eosin is derived from fluorescein, which is a product of the action of phthalic acid on resorcin. The phthalic acid is readily prepared by the oxidation of naphthalene. The resorcin is produced by fusing the sodium salt of benzol-disulphonic acid with soda. Heating the resorcin and phthalic acid together gives fluorescein;

and treating this with bromine gives tetrabromfluorescein, of which eosin is the potassium salt. The price of eosin is 100 francs a kilogramme.

Weselsky has shown that phloroglucin is a very delicate test for nitrous acid. Very dilute solutions of phloroglucin and toluidine (or aniline) nitrate become dark orange on the addition of a few drops of a dilute solution of potassium nitrite, and a cinnabar red powder is thrown down.

Jacquemin has examined the methods proposed for the detection of fuchsin in wine, founded on its tinctorial power. As is well known, this substance is extensively used for this purpose. Pyroxylin and wool may be dyed directly in the wine, but to prove the presence of fuchsin finally, the ammonia process is necessary.

Liebermann and Fischer have further examined chrysophanic acid, the active principle of rhubarb. They find it to stand to emodin, its associate, precisely as alizarin stands to purpurin, only both the former are homologous with the latter, being derivatives of methylanthracene. Chrysophanic acid is dioxymethylanthraquinone.

Graebe and Caro have made an extended investigation of rosolic acid, restricting this name to the substance obtained by the action of nitrous acid on rosaniline and subsequent treatment with water. They find that it is capable of giving a series of tetra-substitution products, and is analogous, therefore, with the phthaleins of resorcin and orcin described by Baeyer. Reduction yields both hydrorosolic acid and leucorosolic acid, and from these come tetrabromleucorosolic acid and hydrocyantetrabromrosolic acid.

Hlasiwetz and Habermann have examined the chemical characters of gentisin and of gentisinic acid, into which and phloroglucin the former is decomposed. This acid by heat yields carbon dioxide and hydroquinone.

Butlerow has made some experiments with the milky juice of *Cynanchum acutum*, Linn. He finds in it a volatile alkaloid and a white gum-resin, probably a phenol, to which he gives the name cynanchol.

Williamson has described some metallic derivatives of coumarin, containing the metals sodium, potassium, barium, silver, and lead.

Wartha has investigated more minutely the coloring matter of litmus, and has shown that the commercial article always contains indigo. He gives directions for preparing the coloring matter pure.

Tiemann and Haarmann have described a method for the accurate determination of vanillin in vanilla, and have shown that the price of the commercial varieties is not always in accord with their content in vanillin.

Latour and Cazeneuve have separated from mahogany an astringent substance containing carbon, oxygen, and hydrogen, which is crystalline, and identical with catechin.

Prescott has given the results of his determinations of the solubilities of the alkaloids, in the crystalline, amorphous, and nascent conditions, in ether, chloroform, amyl alcohol, and benzine respectively, these solvents having been washed with water before use.

Hesse has communicated a preliminary note, in which he says he has found in a rare cusco bark an alkaloid which appears to agree with the cusconine of Leverköhn, and to be closely allied to the aricine of Howard.

Glenard has investigated the alkaloid of ipecacuanha, emetine. It was obtained in small hemispherical warty crystalline masses, which, on purification, gave milk-white crystals. From the analysis of the alkaloid itself and of its chlorhydrate, the formula $C_{15}H_{22}NO_2$ is assigned to it.

Schmidt has investigated the action of hydrogen sulphide on the alkaloids, and has produced compounds of it with strychnine and brucine.

Hess has examined minutely the character of opianine, an alkaloid derived from Egyptian opium, and concludes that it is nothing but pure narcotine.

Mallet has published a theoretical paper on the rational formula of urea, uric acid, and their derivatives.

Hill has communicated from the organic laboratory of Harvard College a paper on the ethers of uric acid.

Ritthausen has further examined a nitrogenous substance found by him in the juice of the vetch (*Vicia sativa*), and, finding it to be new, gives to it the name vicin. It has properties analogous to those of asparagin.

Struve has confirmed the opinion of Lechartier and Bellamy that fruits in the absence of oxygen ferment, evolving carbonic gas and producing alcohol, though there can not be discerned any yeast cells in them by the microscope.

Paper and cardboard made from peat were recently presented at a meeting of the Berlin Polytechnic Society, and a factory for its manufacture is about to be erected in Prussia. The paper resembles in quality that made from wood or straw.

In *Physiological Chemistry*, Schutzenberger has continued his valuable researches on albumin and the albuminates.

Gautier and his pupil Scolosuboff have made an extended examination on arsenic in the tissues, and have shown that it principally localizes itself in the nervous tissues. They also describe an improved method of separating it from organic matters.

Commaille has given a means of separating cholesterin from the fatty matters with which it is generally accompanied, and which are often mistaken for it, by taking advantage of the property which cholesterin has of resisting the action of concentrated alkalies, even when boiling.

MINERALOGY.

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PUBLICATIONS, RESEARCHES, ETC.

Several important works on Mineralogy have been published during the year past. First among these stands Rammelsberg's "Handbook of Mineral Chemistry." This is a most valuable contribution to the science, both on account of the high position which the author holds in the department, and also because it is the first complete work in which the chemical composition of minerals has been discussed with sole reference to the principles of the New Chemistry. It thus marks an era in the science, since hitherto the new formulas, if given at all, have generally been made subordinate to those of the *old* system.

The "Physical Crystallography" of Professor Groth is also an important work, since it gives a full and systematic, and yet very intelligible discussion of the optical characters of crystals, and the means employed in their investigation. Other new works are the Crystallographies of Klein and of Sadebeck; the former discussing the methods of calculation, and the latter the *natural history* of crystals, their method of growth, and so on. The new (5th) Appendix by Domeyko to his "Mineralogy" may also be mentioned; the new minerals described in it are enumerated in the list which follows.

Two mineralogical societies have recently been inaugurated in England, one of which is called the "*h k l*," after Professor Miller's classical crystallographic symbols. Moreover, it has been announced that a new journal, to be devoted exclusively to Mineralogy, is soon to be commenced in Germany; the design is to make it decidedly cosmopolitan in its nature.

In the department of Physical Mineralogy important researches have been published by Hankel, Groth, and others. Hankel has continued his investigations of the pyro-electrical properties of minerals, and has shown that these belong, not, as once supposed, to a few hemihedral minerals alone, as tourmaline, but to all species in a more or less decided degree. Moreover, he has shown that these characters are determined, analogously to the optical properties, by the symmetry of the crystalline form; for instance, in a tetragonal or hexagonal crystal the same kind of electricity is developed in all lateral directions, that is, upon all prismatic planes, but the opposite kind at the extremities of the vertical axis. Groth has determined the coefficient of elasticity of rods of rock-salt by a series of delicate acoustical experiments. These rods were cut in different directions from the crystal of salt, and the main result arrived at is the proof that the elasticity has different values in different directions, but the same value in all directions crystallographically identical.

Baumhauer has continued his researches upon the figures produced upon the surfaces of crystals of lepidolite, tourmaline, and other minerals by means of various modes of etching. The same method of investigation has proved, in his hands, that crystals of mimetite and pyromorphite are hemihedrally developed in the same way as those of apatite, though it is not apparent in their external forms.

The accurate measurements of crystals of analcite by Schrauf have led him to the conclusion that it, like leucite, must be transferred to the list of tetragonal crystals (instead of isometric). It is claimed, however, by Hirschwald that both species are truly isometric, though showing the phenomena of "polysymmetry." Tschermak has also shown that the common mica, muscovite, is monoclinic, not orthorhombic.

The crystals of chondrodite from Brewster, N. Y., have been shown by an American crystallographer to embrace the same three types of forms that characterize the volcanic mineral humite, of Vesuvius; moreover, the optical characters of the second and third types show them to be *monoclinic*, though they do not agree between themselves. Des Cloizeaux has supplemented these observations by a like examination of the Vesuvian mineral (humite), and has thus shown that the three types must be considered three distinct species; which he proposes to call respectively *humite*, *chondrodite*, and *clinohumite*.

A number of new and strange cases of the association in parallel position of crystals of two distinct species have been described; thus, pyroxene on hornblende, humite on chrysolite, etc. The most remarkable case is that of quartz on calcite, an interesting form of which has been figured from "Specimen Mountain," in the Yellowstone National Park.

A related though quite different subject is the inclosure of one crystal by another, as the strange envelopment of orthoclase by tourmaline described by E. H. Williams (*Amer. Journal of Science*, Feb., 1876). The presence of liquid carbon dioxide in minerals has been confirmed by Hartley, and some new facts in regard to it published. His studies have led him to suggest the idea that *diamonds* may have been formed by the action of reducing agents on very highly compressed carbon dioxide. Dr. Isaac Lea has continued his study of the inclusions, both liquid and solid, by some gems, as sapphire, spinel, etc.

The new localities of American minerals, spoken of in the last volume of the *Record*, have been further developed during the year, and yielded many fine specimens. Of new occurrences of some interest may be mentioned the staurolite crystals of Fannin Co., Georgia; the pyrrhotite of Elizabethtown, Ontario; the quartz and rutile of White Plains, North Carolina, the former very fine in color and transparency; the columbite from Standish, Maine; sphene from Bridgewater Station, Pennsylvania, and so on.

As the tellurium minerals of this country have exerted a good deal of interest of late years, it is worth noting that some tellurium compounds (hessite, altaite) have been discovered by Domeyko in Chili.

NEW MINERAL SPECIES.

The energy of mineralogists during the past year seems to have been especially directed to the discovery of new species, for the number of new names introduced into the vocabulary of the science is very large. It is probable, however, that some of the newly made species may not have a very long existence. The following is the list of species announced as new:

Achrematite.—A molybdo-arsenate of lead, of a yellow color, and indistinct crystalline structure. The locality is Guanaceré, Chihuahua, Mexico. Described by Professor J. W. Mallet.

Aerinite.—Essentially a hydrous silicate of iron and aluminum, characterized by its intense azure-blue color. The structure is massive and earthy. It forms the paste which binds together fragments of quartz, chrysolite, feldspar, and augite, and has probably itself arisen from the decomposition of other silicates. Locality, Spain.

Calcozincite.—A doubtful mineral containing zinc, calcium, water, and carbonic acid. Massive; color, orange-red. Sterling Hill, N. J.

Cuprocalcite.—A basic carbonate of copper and calcium, somewhat allied to malachite, but having an intense vermilion-red color. Occurs in small massive fragments in carbonate of calcium. From the mines of Canza, in Peru.

Clinohumite.—The third type of humite. (See above.)

Daubréelite.—Proto-sulphide of chromium, occurring as a coating of triolite nodules in the meteoric irons of Northern Mexico. Described by Professor J. Lawrence Smith.

Daubreite.—An oxychloride of bismuth, from the Constancia Mine, in Bolivia. Amorphous, structure somewhat fibrous; the color yellow and yellowish gray. Specific gravity 6.5, and hardness 2.5 (Domeyko). Both this and the preceding species named for M. Daubrée, of Paris.

Euchlorite.—A silicate of iron and magnesium. Occurs in coarse scales, with a light olive-green color. Distinctive characters, wanting. Chester, Mass.

Friedelite.—A hydrous manganese silicate, allied to hydrotephroite. Occurs in hexagonal plates and in granular masses; color, rose-red.

Adervielle, Hautes-Pyrenées. Named by M. Bertrand in honor of M. Friedel.

Gastaldite.—A member of the amphibole group of minerals, but in composition essentially a silicate of aluminum. Found in chloritic slate in the valley of Aosta; occurs in prismatic crystals; color, dark-blue. Named by Sr. Strüver in honor of Sr. Gastaldi.

Hermannolite.—A mineral very near if not identical with columbite, from the old locality at Haddam, Conn. Supposed to differ in chemical composition.

Huantajayite.—A chloride of sodium and silver, allied to halite and cerargyrite. Crystallizes in cubes of a white color. From the mine of San Simon, Cerro de Huantajaya, Chili.

Hydrotitanite.—A mineral which has been produced by the alteration of crystals of perofskite; all the lime and some of the iron having been removed, and water been taken up. The crystals have retained their original form, but the color has become grayish white. Locality, Magnet Cove, Arkansas. Described by Dr. Koenig, of Philadelphia.

Ihleite.—A hydrous sulphate of iron; occurs as a yellow efflorescence on the graphite of Mugrau, Bohemia.

Keatingine.—A variety of fowlerite, from Franklin, N. J.

Krönkite.—A double sulphate of copper and sodium, of a brilliant blue color; and occurring in crystalline masses having a prismatic structure. It feels moist to the touch, and upon prolonged exposure to the air it becomes greenish, and partly loses its transparency. From the mines of Calama, in Bolivia.

Leviglianite.—A ferriferous variety of guadalcazarite, from Leviglianі, Italy.

Malinowskite.—A variety of tetrahedrite, containing considerable silver and lead. From the mine of Carpa, Peru.

Melanophlogite.—Occurs in minute cubes, having a light brownish color, which are implanted on calcite and celestite from Sicily. The mineral contains silica, sulphuric oxide, and water, though the exact composition is yet doubtful. The hardness is nearly that of quartz. Its most peculiar character, to which it owes its name, is that it turns black on being heated.

Microschörlite and *Microvermiculite* are names given by Herold to microscopic crystals, of uncertain nature, observed in the kaolin of Thuringia.

Mottramite.—A hydrous vanadate of copper and lead, occurring as a black, velvety incrustation on sandstone. At Mottram St. Andrew's, Cheshire, England. Described by Professor Roscoe.

Parankerite.—A name given by Boricky to a special group of the minerals which are embraced under the general term of *ankerite;* that is, carbonates of calcium, magnesium, and iron, in varying proportions. From Bohemia.

Pelhamine.—A variety of serpentine of uncertain character. Pelham, Mass.

Phillipite.—A hydrous sulphate of copper and iron. Occurs in small masses of a deep-blue color in a clay. Province of Santiago, Chili.

Pilinite.—A hydrous silicate of aluminum and calcium; allied to the zeolites. Found in fine, white, flexible needles, having a silky lustre, in the granite of Striegau, Silesia.

Psittacinite.—A hydrous vanadate of lead and copper, nearly allied to mottramite. (See above.) Occurs in thin, crypto-crystalline coatings of a green color. Silver Star District, Montana. Described by Dr. Genth.

Pyroconite.—Identical with pachnolite. Greenland.

Roscoelite.—A vanadate of aluminum and potassium, described by Professor Roscoe, and also by Dr. Genth, with different results. Occurs in scales grouped in stellate or fan-shaped groups; the color greenish gray. Found in small seams in a gold-mine at Granite Creek, El Dorado County, California. Named by the discoverer, Dr. James Blake, for Professor Roscoe.

Schraufite.—A new fossil resin, of a hyacinth-red color; from Bukowina.

Siderazot.—Nitride of iron; found at the volcano of Etna.

Vanuxemite.—Supposed to be a hydrous silicate of aluminum and zinc. From Sterling Hill, N. J.

Werthemanite.—A subsulphate of aluminum, differing from aluminite in containing less water. Found near the city of Chachapoyas, Peru.

GEOLOGY.

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The Geological explorations which, under the authority of the United States government, have been going on for the last few years in the western part of our territory, have reached a point where it becomes possible to generalize the observations.

GEOLOGY OF THE FORTIETH PARALLEL.

Clarence King has given us, in anticipation of his published volume, an important contribution to the history of the Paleozoic series as displayed along a belt of about one hundred miles in breadth, following the 40th and 41st parallels of latitude from the 104th to the 120th meridian, or from the eastern base of the Rocky Mountains to the confines of California. By a careful study of the outcrops and of their organic remains, he and his assistants have been able to make out the succession, and to correlate the various divisions with the New York series of rocks. The Paleozoic strata of the eastern half of the continent, generally estimated at 40,000 feet in Pennsylvania, are diminished to about one tenth of that thickness on the Mississippi; and in the eastern part of the Rocky Mountains have a total thickness of not more than from 900 to 1200 feet, including at the base Cambrian, and at the summit Carboniferous strata; the whole forming apparently one conformable sequence, which rests in discordance upon crystalline rocks of Eozoic age. This Paleozoic series rapidly thickens westward to a volume of not less than 32,000 feet in Utah; and many divisions not recognized in the eastern part of the region under consideration are developed with great force and persistence in Utah and Nevada. Near Battle Mountain, however (longitude 117° 25′), the Paleozoic series is interrupted by a barrier of Eozoic rocks. The Rocky Mountain region was in Paleozoic time a shallow sea, with islands of Eozoic rock, while, beyond, the ocean deepened over a great basin to the western shore.

THE WAHSATCH SECTION.

In the Wahsatch range a single section is seen 30,000 feet in thickness, including Lower Cambrian, and extending through Silurian, Devonian, Carboniferous, and Permian, which latter is overlaid by Trias; the whole succession being without any observable stratigraphical break. The base of this great conformable series consists of quartzites, conglomerates, and slates; attaining in the Wahsatch 12,000 feet in thickness, and, so far as known, destitute of fossils, with the exception of about seventy-five feet of impure limestones and shales at the top, which contain a fauna designated as Potsdam. In Middle Nevada, however, this thin fossiliferous layer is expanded to at least 3000 feet of dark-colored limestones, carrying throughout a Lower Cambrian fauna; while in the Rocky Mountains, to the extreme east, these strata thin out, and never exceed 100 feet.

THE UTE LIMESTONE.

Immediately overlying these Cambrian shales is what is named the Ute limestone which, from 1000 feet to the southward, attains 2000 feet in the Wahsatch; while in Western Nevada, where the calcareous strata of the Potsdam are greatly thickened, we have 4000 or 5000 feet of limestone. In the Wahsatch the middle part alone of this limestone has yielded fossils, which are of Quebec (that is, of Levis or Tremadoc) age, while the great calcareous mass farther west has more than one half its volume of so-called Primordial or Potsdam age, and a portion of Levis; a large part contains forms of Niagara, followed by Lower Helderberg, the precise limits of these not being yet defined.

THE WAHSATCH LIMESTONE.

Succeeding this is the Wahsatch limestone, having a thickness of 7000 to 8000 feet, and containing faunas of Devonian (Upper Helderberg and Chemung) age. This is separated from the Ute limestone by the Ogden quartzite, a green or white sandstone — sometimes schistose and at other times conglomerate—which in different localities varies from 1600 to 700 feet in thickness, and in some parts is wanting, or represented only by silicious impurities in the limestone. It is regarded as the representative of the Schoharie and Cauda-galli grits of New York. The base of the Wahsatch limestone presents in some localities an intermingling of Lower with Upper Helderberg forms — making as yet somewhat uncertain the horizon between Silurian and Devonian. Black slates, which in one locality overlie the Chemung limestone, are supposed to be equivalent to the Genesee group, above which are beds holding a Waverley or Upper Devonian fauna. Still higher in the Wahsatch limestones occur Lower Carboniferous, followed by true Coal-measure forms. This vast body of limestone above the Ogden quartzite thus contains from 1000 to 1400 feet of Devonian, from 1000 to 1200 of sub-Carboniferous and Waverley, and from 4000 to 4500 of true Carboniferous.

THE WEBER QUARTZITE.

To this succeeds the Weber quartzite, which in the Wahsatch has a thickness of 6000 feet, increasing to 9000 or 10,000 feet in the Oquirrh, and probably to even a greater volume in Western Nevada.

With the exception of some red sandstones at the base, it is chiefly a quartzite; though in parts becoming a coarse sandstone, occasionally conglomerate. Though as yet without discovered fossils, it is shown to belong to the Carboniferous from the fact that it is conformably overlaid by 2000 or 2500 feet of shales, sandstones, and chert-beds, with arenaceous limestones, holding throughout Coal-measure forms, and represented in some parts of the distribution by a continuous body of limestone. In the marine limestones of the Wahsatch division there are found, in Middle Nevada, some plant-bearing earthy coal-beds. We have thus a series of at least 16,000 feet of sediments belonging to the true Coal-measures; following which are a few hundred feet of argillaceous, sandy, and calcareous rocks, the fauna of which appears to offer a transition to the Permian. The Permian strata themselves are wanting to the west of the Wahsatch. It is, according to King, a question whether the Eozoic barrier which, in Western Nevada, was the limit to the Paleozoic basin, was continental in its character; if so, it would appear, from the Carboniferous strata in the Blue Mountains of Oregon and the Bass range in California, that it included deep westward bays in which Paleozoic sediments were deposited.

THE BLACK HILLS.

The late observations of Jenney have given us further illustrations of the geological succession in the Black Hills of Dakota. The Eozoic strata of this region, which doubtless once formed an island in the Paleozoic sea, are described as consisting of gneisses, and micaceous, hornblendic, and chloritic schists, with interbedded and intrusive granites, overlaid in apparent unconformity by a series of argillites and quartzites. Both of these series are much disturbed and folded, and include auriferous quartz veins. Resting unconformably upon these are 250 feet of sandstones, which at the base are conglomerate, including fragments of the older rocks and of their auriferous veins; and higher up soft sandstones and shales, with fucoids. Above this are 300 or 400 feet of massive Carboniferous limestone, separated from the underlying fucoidal beds by a few feet of calcareous sandstone, holding the same fauna as the limestone. To this succeeds over 400 feet of red sandstones, limestones, and marls, with gypsum, regarded as Triassic, overlaid by Jurassic strata with an abundant fauna, and not exceeding 500 feet in thickness; to which succeed the Cretaceous and Tertiary strata of the region. The whole section, up to the summit of the Cretaceous, presents no evidence of want of conformity, and offers not more than 700 feet as the representative of the Paleozoic period. The strata below the Carboniferous are by him regarded as Cambrian, and called Potsdam.

THE UINTA MOUNTAINS.

The lately published researches of Powell on the Colorado give us the details of the geological succession in the Uinta Mountains. The sedimentary groups of what he has called the Plateau Province rest upon a series of Eozoic rocks, to which he has given the name of the Red Creek quartzite, consisting of quartzites, interstratified with hornblendic, chloritic, and micaceous schists, in appressed folds. The thickness of these crystalline schists is provisionally put down at 10,000 feet. Resting unconformably upon these rocks, and holding at its base fragments derived from them, is the Uinta group of sandstones, quartzites, and shales, measuring 12,500 feet in thickness, and provisionally regarded by Powell as Devonian. This had suffered great erosion previous to the deposition of the Carboniferous series, and is divided in ascending order into about 400 feet of sandstones, known as the Lodore division, followed by a mass of 2000 feet, chiefly of limestone; above which are the Lower and Upper Aubrey groups, each 1000 feet in thickness, and both consisting of limestones, with some interstratified sandstones and cherty layers, making thus a total of 4400 feet of rocks of Carboniferous age, resting sometimes on the crystalline schists, and sometimes on the eroded Uinta sandstone. In the Grand Cañon of the Colorado, however, the Carboniferous rests in part upon crystalline rocks, which Powell regards, like the Red Creek group, as Eozoic (and which consist of hornblendic and micaceous schists, with beds and dikes of granite), and in part upon what he calls the Grand Cañon group of sediments. These consist of about 10,000 feet of sandstones, shales, and limestones, with imperfectly preserved fossils, probably Cambrian, down to the base. Between this group and the Carboniferous are about 800 feet of sandstones, shales, and limestones, designated as the Tonto group. These are found to rest upon the eroded basset edges of the lower sandstones; and being followed conformably by the Carboniferous, were by Powell assigned to the latter period, though, from the presence in it of Cruziana, it has been referred to a lower horizon. In some parts the Tonto group rests directly upon the crystalline schists.

PALEOZOIC FOSSILS.

The series above the Tonto group, according to White, includes the Lower Carboniferous, Carboniferous, and Permian; while the Grand Cañon strata have yielded as yet but few fossils, among which have been identified only Lingulella and Obolella. In parts of Utah, Nevada, and Arizona he has found trilobites of the genera Olenellus, Conocoryphe, and Agnostus, showing a low Cambrian horizon. The characteristic crustacea of the Levis limestone are met with in several localities, and in one place the Phyllograptus of the so-called

Quebec group. Trenton forms have been found in New Mexico and parts of Arizona and Nevada, associated in the latter region with the characteristic graptolites of the Utica. It would thus appear that the faunas characteristic of all the principal paleozoic divisions of the East are already recognized in different parts of this great Western basin. Large deposits of gypsum, with strong brines, are found in Colorado near the base of the Carboniferous series—a fact which recalls similar deposits at the same horizon in various parts of Eastern North America.

MESOZOIC OF THE WEST.

Powell has, moreover, given us a section of the Mesozoic and Cenozoic rocks. Instead of the conformable succession observed by King, as well as by Hayden, Comstock, Bradley, and more recently by Jenney, for the whole series of Paleozoic and Mesozoic rocks, it has been seen that in the Colorado section we have a stratigraphical break at the base of the Tonto group. Another occurs at the summit of the Carboniferous, upon the eroded edges of which is a conglomerate forming the base of the Mesozoic. The lower Mesozoic here consists of 5200 feet of sandstones and limestones, often cherty, with gypsum at many horizons; the whole series, divided by Powell into four parts, is regarded as the equivalent of the Jurassic, perhaps including at its base a representative of the Triassic.

COAL-BEARING SERIES.

Overlying conformably these gypsiferous and calcareous sandstones are the Cretaceous and Tertiary coal-bearing strata, consisting chiefly of sandstones, carbonaceous shales, and beds of coal or lignite. Of these he refers 6100 feet, including, in ascending order, the Henry's Fork, Sulphur Creek, Salt Wells, and Point of Rocks divisions, to the Cretaceous. Upon the plicated and eroded surface of the latter rests the Bitter Creek group of 3000 feet of sandstones, with some limestone, much gypsum, carbonaceous shales, and numerous lignite beds, followed by 800 feet of the similar strata of the Lower Green River division, upon the eroded surface of which rests a mass of sandstone overlaid by the calcareous beds and lignites of the Upper Green River division, 300 feet in all. This forms the summit of the great lignitic coal-bearing series, of which, as we have seen, 6100 feet are by Powell referred to the Cretaceous, and 4100 to the Tertiary, making a total thickness of 10,200 feet.

Conformably above this comes the Bridger group of 3000 feet of sandstones, chiefly glauconitic, with limestones, marls, and flints, separated by a stratigraphical break from 1800 feet of somewhat similar rocks, called the Brown's Park group; while over the disturbed and eroded surface of this spreads, the highest of all, the Bishop's Mountain conglomerate of 300 feet, making a thickness of Mesozoic and Cenozoic rocks of not less than 19,500 feet, marked by four stratigraphical breaks. If to this we add 16,960 feet for the Carboniferous and Uinta groups, and 10,000 for the sandstones of the Grand Cañon, we shall have a total thickness of 49,460 feet from the base of the Paleozoic series to the summit of the Tertiary in this region.

WESTERN EOZOIC ROCKS.

The study of the geology of this great western half of the American Paleozoic basin shows, as Gilbert remarks, that its rocks were deposited upon a subsiding Paleozoic continent, over which we can trace the advancing shore-line of the Paleozoic sea, which at length covered all but some isolated and more elevated areas. The same state of things obtained to the eastward also, where there is no warrant whatever for the familiar notion, based on a singular misconception, of a continent growing around a Laurentian nucleus. The Paleozoic strata in this western region are every where clearly distinguished by their uncrystalline character from the crystalline Eozoic rocks. In one case only, in New Mexico, quartzose schists, holding hornblende and andalusite, are said to occur interstratified with uncrystalline strata carrying Paleozoic fossils. The fact, however, that these strata are in parts vertical, and are traversed by faults, and brought in contact with gneiss and crystalline schists of admitted Eozoic age, suggests caution in fixing the horizon of these supposed Paleozoic crystalline schists. Different observers have referred portions of these crystalline rocks to the Laurentian and the Montalban series; but careful studies are yet wanting to establish their true relations.

METALLIFEROUS DEPOSITS.

A great part of the deposits of the precious metals in this western region are in veins in the Eozoic rocks, but it is well known that they occur also in the Cambrian and the Carboniferous rocks; while silver ores are found impregnating rocks of Cretaceous age, showing that the transportation of the precious metals has been going on up to a comparatively late period.

ERUPTIVE ROCKS.

Eruptive rocks, as is well known, are found penetrating and overlying the strata even of later tertiary age in the West. According to Richthofen, there was a natural and constant order in their extravasation, the acidic rocks — trachytes and rhyolites — being always older, and the basic rocks—basalts and dolerites—newer, penetrating and overlying the former. This would seem to be an instance of hasty and imperfect generalization. The writer has long since shown that some of the eruptive dolerites of Canada are of pre-Paleozoic age; and the observations of Le Conte and of James

Blake in the West (*Record*, 1874, lxxi.) have made known the existence of repeated intercalations, by successive outflows, of trachytic and doleritic rocks. Marvine has since pointed out another instance of the kind in Nevada, where two or more beds of dark-colored olivenitic basalt, with interposed sandstones, are capped by a great mass of pinkish trachyte or rhyolite holding sanidine and quartz, and including pebbles of the underlying basalt.

CRYSTALLINE ROCKS OF MICHIGAN.

The crystalline schists of the northern peninsula of Michigan have been again discussed by Brooks, who, after the Canada Survey, has referred them to the Huronian period. He calls further attention to the existence at the summit of the series of a group of granitic rocks, with hornblendic and micaceous schists holding staurolite and garnet, the whole being, according to him, apparently younger and different in character from any of the known Huronian rocks. The writer had already described these rocks in 1871, and then referred them to the White Mountain or Montalban series, of which they have both the lithological characters and the geognostical relations.

THE KEWEENIAN SERIES.

The series of sandstones and trappean rocks which carry the native copper of Lake Superior has been by Irving studied in Wisconsin, where is found a westward extension of the Lake Superior synclinal of these rocks, and where they have an apparent thickness of more than 20,000 feet. They are there as clearly distinct from the underlying Huronian series as from the overlying horizontal sandstones of Lake Superior, which are, according to Irving, traced westward beneath the Lower Paleozoic sandstones of the Mississippi Valley, of which they are apparently inferior members. Brooks now concludes that the granitoid and micaceous formation just noticed, which he places at the summit of the Huronian, is unconformably overlaid by the copper-bearing formation, which he proposes to recognize as a distinct series under the name of Keweenawian. The writer had, however, already in 1873 named it the Keweenaw series; and if an adjective is desired, Keweenian will be more euphonious than the word proposed by Brooks. The evidence, then, is to the effect that the succession in this region is: 1. Laurentian; 2. Huronian; 3. Montalban; 4. Keweenian; 5. Lower Cambrian—to which period the overlying sandstones must be referred. This disposes of Bradley's late strange suggestion that the Huronian is probably altered Lower Silurian—that is to say, Lower Cambrian.

CRYSTALLINE ROCKS OF PENNSYLVANIA.

Hunt has described the crystalline rocks of the South Mountain between the Delaware and the Schuylkill, and of the Welsh Mountain between the latter river and the Susquehanna, as clearly of Laurentian age, and has referred to the Montalban, the Philadelphia gneiss and mica-slate series. He points out the existence of a hitherto unnoticed Laurentian belt farther to the southeast, which separates the Auroral limestones on that side of the Mesozoic from the Montalban series; and he notices between the latter and the Laurentian a belt of Huronian strata of varying breadth, which is probably unconformable with the Laurentian. He moreover describes the South Mountain range, where it reappears again to the south of the Susquehanna, as consisting, in Pennsylvania, chiefly of a large development of Huronian strata, including great interstratified masses of orthofelsite or petrosilex rocks (the hälleflinta of the Swedish geologists), which frequently pass into a quartziferous feldspar-porphyry, generally of some reddish color. These acidic rocks represent in the Huronian the gneisses of the Laurentian and the Montalban, and here, as elsewhere, are found to be distinctly stratified, and intercalated with greenstones and chloritic and epidotic rocks. He regards them as the equivalents of similar rocks which form a part of the Huronian series along the eastern coast of New England and New Brunswick, and of the iron-bearing orthofelsite porphyries of Missouri. They are also developed along the northern shore of Lake Superior, and their ruins enter largely into the conglomerates of the Keweenian series in Northern Michigan.

LOWER TACONIC ROCKS.

Hunt has further described the characters of the Primal and Auroral rocks of Rogers, as seen in the region to the southeast of the North Mountain in Pennsylvania. These rocks were assumed by Rogers to be the stratigraphical equivalents of the Potsdam, Calciferous and Chazy of the New York series, and of the undoubted representatives of these which occur west of the North Mountain. They are the Lower Taconic quartzites and limestones of Emmons, maintained by him to occupy a lower horizon than the base of the New York fossiliferous series. They constitute, according to Hunt, a partially crystalline series, distinct from and newer than the Huronian and Montalban. Interposed in the detrital rocks of the Primal are schistose beds charged with micaceous and chloritic matters, crystalline limestones often inclosing serpentine, and important beds of magnetite, as at Boyertown, Cornwall, and Dillsburg, all of which present mineralogical characters unlike those of the underlying crystallines. Similar conditions extend into the Auroral magnesian limestone, giving to these two formations a distinctive character. They were evidently deposited over a subsiding continent with bold shores, so that while the Primal has in some places a very great thickness, it is elsewhere very thin or entirely wanting beneath the Auroral, which rests directly upon the older crystalline rocks.

INVERSIONS OF STRATA.

Hunt further points out that we have in this region many illustrations of what seems to be a common fact, that when newer strata deposited around the base of a ridge or barrier of older rocks have been subjected to folding, they often assume a dip toward the barrier. The movement in such cases, apparently due to lateral pressure, has sometimes even involved the older rock itself, and caused it to be folded over, so that the newer strata are actually inverted and overlaid by the older and unconformable rocks, as may be seen in the South Mountain in New Jersey.

ORIGIN OF LIMONITES.

The presence in these Primal and Auroral strata of great beds and masses of pyrites, and of others of carbonate of iron, is also noted; and where, as is often the case, these rocks are deeply altered by meteoric agencies, the sulphuret and carbonate have been changed into hydrated oxide of iron, which, in the form of limonite, abounds in the clays resulting from this process of decomposition.

DECAY OF ROCKS.

This decay of the strata, so noticeable in these Lower Taconic rocks, is also seen in the Laurentian gneisses of the South Mountain, where these are protected from erosion. In such cases the partially decomposed feldspathic rocks often contain nuclear masses of the unchanged rock — boulders of decomposition. Belt has pointed out in Nicaragua examples of the slipping or sliding of such decayed rocks on a mountain-side, by which undecayed portions are carried down the slope and involved in the displaced material. Kerr has lately further illustrated the question in North Carolina by showing that alternate freezing and thawing of such decayed rocks on a declivity may cause the descent of the material, with scratching of the surface, thus giving rise locally to phenomena similar to those often ascribed to sub-aerial glaciers. Such movements of decayed crystalline rocks, either with or without the aid of congelation, have no doubt in some regions been mistaken for the result of ice-action.

LAURENTIAN AND NORIAN OF THE ADIRONDACKS.

Professor James Hall has studied the arrangement and distribution of the crystalline rocks in parts of the Adirondack region, and has verified the old observations of the Canadian Survey that the labradorite and hyperthene rocks, with titanic iron ores—the Norian series—rest unconformably upon the Laurentian gneisses, which contain the pure magnetic ores of the region.

CRYSTALLINE LIMESTONES.

Hall finds that certain serpentinic limestones of the region are newer than both of these series, which they overlie unconformably, including at the same time fragments derived from the gneisses. That crystalline limestones containing serpentine and various other minerals do, however, form portions of the Laurentian series in Canada is undoubted, but it by no means follows that all such crystalline limestones belong to this horizon. Hunt has pointed out that limestones, much resembling in mineralogical characters those of the Laurentian, occur in the Montalban of New England, and also, as noticed above, that serpentinic limestones are found in the Lower Taconic rocks of Pennsylvania. These facts give an additional interest to the important observations of Hall. Some late researches of Vennor in the province of Ontario tend to similar conclusions.

THE QUEBEC GROUP OR UPPER TACONIC.

The fauna of the Lower Taconic rocks in Pennsylvania is scarcely known, but in addition to a Scolithus, which differs from that of the New York Potsdam, Prime has made known the existence of an undetermined linguloid shell, and also of impressions similar to the Monocraterion found by Torell in the lowest Cambrian beds of Sweden. Referring to the lower divisions of Paleozoic time, Hunt has again called attention to the fact that the so-called Quebec group of Logan (the Upper Taconic of Emmons) was based upon an inverted succession of strata on an overturned anticlinal. The slates with compound graptolites, of the Levis division, which were represented by Logan as inferior to the Levis limestones, are of the age of the Skiddaw or Arenig rocks, while the limestones themselves are the equivalents of the Tremadoc division of Great Britain. The Sillery, which was regarded as the summit of the Quebec group, is much lower, and probably of Menevian age. In the province of Quebec it rests in some localities on the crystalline schists of Huronian age, which were supposed by Logan to be the Levis and the overlying Lauzon division in an altered condition, although the Levis rocks are now shown by their fauna to belong to the upper part of the series, and contain fragments of these same crystalline schists.

CRYSTALLINE ROCKS OF SCANDINAVIA.

Pettersen has described the crystalline rocks of Northern Norway as including an older series of red and gray gneisses, often hornblendic, with micaceous and hornblendic schists and much crystalline limestone. These are overlaid by a series of argillaceous and hornblendic rocks, with gabbro (diorite or diabase) olivine-rock, serpentine and steatite, and associated copper and nickel ores. Related strata are described by him as a series of many-colored argillites, with greenstones, ferriferous dolomites, red hematites, and copper ores. These groups of metalliferous strata are much contorted, without organic remains, and are conjectured by Pettersen to be either of Silurian or Devonian age, though they have the characteristics of Huronian rocks. In other parts of Scandinavia the notion of altered Paleozoic rocks is carried to a much greater extent, and, according to Tornebōhm, all the various types of crystalline Eozoic rocks, including the granitoid gneisses, are reproduced again at a higher horizon, the fossiliferous Paleozoic rocks which repose on the Eozoic being supposed to pass beneath, and to be more ancient than this second and newer set of crystalline strata. It remains to be seen whether this is really the case, or whether this apparent superposition results from the same structure as has been described above in the Appalachians.

MARBLES OF CARRARA.

A similar question continues to occupy the geologists of Southern Europe, where the crystalline rocks of the Alps, Apennines, and Pyrenees have been by different observers assigned to very different horizons. The statuary marbles of Carrara are an example of this. A generation since they were looked upon as eruptive; then, together with their associated crystalline schists, they were declared to be altered Cretaceous. They were subsequently referred to the Lias, until shown to be unconformably overlaid by Liassic strata and to rest in discordant stratification on crystalline schists, when they were assumed to be altered strata of Rhætic age. Later observations placed them beneath the coal-measures, and the Carrara marbles were then called Lower Carboniferous, to which horizon some have also referred all the statuary marbles and micaceous limestones of Central Italy. Similar statuary marbles in the Pyrenees, formerly regarded as altered Mesozoic, are now considered to be Carboniferous, or still older. According to Gastaldi the marbles and micaceous limestones of Italy just referred to are still more ancient, and are closely related to the *Pietre verdi* group; so that their position, if not pre-Paleozoic, is at the very base of the Paleozoic series.

CRYSTALLINE ROCKS OF ITALY.

The name of the *Pietre verdi* or greenstone group, is given in Italy to a widely spread series of stratified rocks of great thickness. It consists, to a large extent, of rocks with triclinic feldspars—the so-called gabbros and diabases—together with great masses of serpentine, and diallage, and steatitic, chloritic, and epidotic strata, the whole associated with quartzose and calcareous schists. These rocks have been by most geologists looked upon either as eruptive or as contact-deposits resulting from the action of eruptive masses upon uncrystalline strata, and have been assigned, from their supposed stratigraphical relations, to very different geological ages. According to Lory they are Triassic, while within the past year some have been found closely associated with Silurian or Devonian fossiliferous strata. De Stefani assigns certain of them to a horizon between the Carboniferous and the Lias, others of them he refers to the Cretaceous, and others still are stated by him to overlie the middle and lower Eocene. Gastaldi has, however, recently reviewed the whole subject, and concludes that the rocks of the *Pietre verdi* are not eruptive but indigenous, and constitute a well-defined series of beds and lenticular masses, of great thickness, in which the serpentines occupy a position near the base. The *Pietre verdi* has, according to him, a constant and well-defined horizon, which is pre-Paleozoic, and its rocks never make their appearance in other formations. This formation, which has all the characters of the Huronian, to which he has provisionally referred it, rests unconformably upon a great series of gneissic rocks, often porphyroid and granitoid, which include deposits of graphite, beds of quartzite, lenticular masses of white statuary marble, and doubtless represent the Laurentian. Overlying the *Pietre verdi* is another great series of quartzites, and schistose limestones and dolomites, including beds of gypsum near the summit. These groups of ancient crystalline strata, according to Gastaldi, constitute the basal rocks of the Alps and Apennines, and may be followed from Mont Blanc to the Danube, the Adriatic, the Mediterranean, and to the plains of France, overlaid in part by newer strata. These views are in accordance with those maintained by Favre and many others, who have shown by repeated instances that the apparent interstratification of older among newer rocks in these regions is due to inversions and dislocation. The writer, some years ago, from his studies of Alpine geology, was led to maintain the view defended by Gastaldi, and asserted the Eozoic age of these crystalline rocks, including the *Pietre verdi.*

CAMBRIAN ROCKS OF EUROPE.

Hicks has discussed the different conditions presented by the Cambrian and Siluro-Cambrian rocks in Wales, where they have a united thickness of 30,000 feet, and in Scandinavia and Russia, where they are 1000 feet or less. He supposes them to have been deposited over a slowly subsiding continent of Eozoic rocks, the surface of which sloped toward a deep ocean to the southwest, and in accordance with this view concludes that the earlier members of the Cambrian below the Menevian horizon are wanting in Scandinavia, which was not submerged till then. To this Linnarsson objects, maintaining that both the Menevian and the fossiliferous Harlech strata, which underlie it in Wales, are represented by the Paradoxides beds of Scandinavia, where below these are still recognized two distinct horizons of Paleozoic sediments, the Fucoidal sandstone and the underlying Eophyton sandstone. Neither of these contain any trilobites, but they afford brachiopods, pteropods, sponges, etc., besides the moulds of what are regarded by Torell as two radiate animals, designated by him as Monocraterion and Diplocraterion. The thickness of these two sandstones in Middle Sweden is but 100 feet, but in Northern Norway they equal 2000 feet, and include schists and limestones. Above the Paradoxides beds in Sweden are the Olenus beds, which, although but forty feet in thickness, are supposed to represent the 4000 feet of Lingula flags found in Wales between the Menevian and the Tremadoc. Linnarsson concludes that the Paleozoic sediments known in Scandinavia are at least as old as any thing discovered in Wales, where, however, there are 1500 feet of sediments known beneath the Harlech trilobites. The fossiliferous schists of the Baltic provinces of Russia, which are referred to a horizon above the Lingula flags, have conformably beneath them several hundred feet of shales and friable sandstone, the so-called Ungulite grits, of the fauna of which very little is known, and which rest directly on the crystalline rocks. The primordial zone of Barrande, in Bohemia, is regarded by Linnarsson as equivalent to the middle portion of the Paradoxides beds of Sweden; although no species of crustaceans are common to the two, there are many analogous forms. Linnarsson on paleontological grounds rejects, as we have seen, the view that the basal fossiliferous rocks of Scandinavia are less ancient than those of Wales; but the constantly recurring question comes up whether such a similarity or identity of organic forms in widely separated regions indicates synchronous deposition, or whether the successive appearance and disappearance of these in Scandinavia may not have occurred at a somewhat later period than in Wales.

CARBONIFEROUS ROCKS IN GERMANY.

The great region of sedimentary rocks in Moravia and Silesia, long known for its roofing-slates, remained without any evidence of its geological age until 1860, when fossils of Carboniferous age were found, which showed its equivalence to the Culm formation of Nassau. Since then the structure of this great mass has been unraveled, and it has been shown to consist of three divisions, each of which carries an abundant fauna of Carboniferous age, now first described by Steer, and a marine Paleozoic fauna. These three divisions, which are of nearly equal thickness, each consist of sandstones and conglomerates, with roofing-slates, and have a united thickness of 70,000 or 80,000 feet.

ARCTIC GEOLOGY.

Nordenskjöld, from the results of his long researches in arctic geology, attempts to discuss the question of the arctic climate in former geological periods. We have there no clear evidence with regard to the Silurian and Devonian ages; but in the Carboniferous time there was an extensive continental area around the pole, supporting a colossal vegetation, the remains of which, inclosed in sandstones, rest in Spitzbergen upon a great formation of marine limestone rich in corals of Carboniferous age. The Trias of this region shows gigantic cephalopods and great saurians, which also point to a tropical climate, and the succeeding Jurassic in Spitzbergen is terrestrial, with large cycads and conifers. The Cretaceous of the polar regions also, according to this same observer, shows two horizons—a lower one, with a flora which Heer compares to that of Egypt, and an upper, which contains a great variety of deciduous trees, and indicates, for the first time, a slight change of climate. The Eocene is wanting in these regions; but we have the wonderful Miocene flora, which was spread over a great arctic continental area, and is well known to have resembled that of Central Europe, or of the Ohio valley of to-day.

FORMER ARCTIC CLIMATE.

Nordenskjöld, moreover, fails to find evidences of former glacial agencies in the sandstones of these regions from which we might infer the former existence of alternations of warm and cold climates. The advent of frost followed the Miocene period. Recent speculations have revived the old notion of a possible change of the earth's axis of rotation as a way of explaining this change of arctic climate; but such a phenomenon is astronomically improbable, and is also opposed by the fact that the direction of oceanic currents, which are guided by the earth's rotation, appears, from the distribution of marine sediments, to have been the same since very early periods. Something may have been due to the depression of parts of the present continents, which may have permitted the influx of warm waters into arctic seas, but the evidence shows the existence of arctic continental areas charged with vegetation. A simple solution of the problem seems to be that long since proposed by the present writer, that the presence of a larger amount of carbonic acid in the atmosphere up to a late period, maintained, in accordance with well-ascertained physical laws, a tropical temperature over the whole earth's surface, at the sea-level.

ANTARCTIC CLIMATE.

In this connection may be noted the question of a glacial period in the southern hemisphere. McCoy, from his studies of the fossil forms of Southern Australia, concludes that there is no evidence of a former period of greater cold, but that there has been a gradual diminution of temperature down to the present time. Hutton shows that the evidence in New Zealand is to the same effect, as Hector had already done before him.

THEORIES OF GLACIATION.

The bearing of these observations and conclusions on theories of glaciation is important. While some are content to limit the action of ice to superficial modifications of the surface, others, as is well known, maintain that the grandest valleys and the deepest and broadest lakes have been sculptured by its agency, and that no former distribution of land and water is sufficient to explain the extent of the ancient glaciers; which were ice-caps stretching from the poles to the equator, to explain the existence of which it is necessary to resort to astronomical causes. These causes, according to different theorists, would involve both hemispheres either simultaneously or alternately, giving a succession of glacial periods which, it is claimed, can be traced far backward in geologic time. Such views, it is evident, are not easily conciliated with the late observations in the arctic regions, in New Zealand, and in Australia; and some of our best physicists and astronomers venture to question the soundness of the astronomical hypotheses of this school of glacialists. The marks of a universal ice-sheet should be found all around the globe in the same latitude and at the same levels, while it is well known that glacial phenomena are limited to certain meridians, and that great breadths afford no indications of ice-action. Hence the view of local glaciers of great extent, the origin of which it is possible to explain by geographical causes alone, now finds favor with many, while increasing attention is given to the action of ice-floes and shore-ice.

There are many problems relating to erosion and the transport of materials which it is attempted to explain by glacial agency, and the question how far this has been operative is now being discussed by many observers, especially in Great Britain. In opposition to the views of Goodchild, who supposes them due to the eroding action of a great ice-sheet, Miller endeavors to show that certain escarpments in Yorkshire must have been pre-glacial, and Mackintosh maintains that many of the phenomena referred to ice must have been caused by marine action. Tylor in the mean time urges, with great ingenuity, that the present surface-outlines were determined by the action of water rather than of ice, and would substitute for the Glacial a Pluvial period, in which rains, springs, rivers, tides, and currents were far more active than at present — an exaggeration which may be set against those of the other school.

GLACIERS AS ERODING AGENTS.

An important question which, it would seem, should take precedence of all others in the discussion as to the origin and distribution of glaciers or ice-sheets as geological agents, is whether glaciers can act as eroding agents. Bonney furnishes his contribution to the subject by showing, as the result of long studies of Alpine glaciers, that the plasticity of ice is such that it flows like a river over and around obstacles instead of sweeping them away. An Alpine glacier advancing over a tolerably level surface overrides the loose material in front, scarcely disturbing it, and the great retreating glaciers leave behind them nothing like the boulder-clay or ground moraine; the detrital matter from them, which is small in amount, being, like that of the terminal moraines, derived from the surface of the glacier. He argues that the glaciers, though they have moulded surfaces, have not excavated nor modified the features of the valleys, which are anterior to the glaciers, and are due to fluviatile agencies. There are phenomena of surface-geology for which the hypothesis of great glaciers offers a plausible solution; but it must be received with many limitations, while the objections which are urged against it are such that the present attitude of many judicial minds is at least one of doubt.

GEOGRAPHY.

By Lieutenant-Commander F. M. GREEN, U. S. N.

Although the progress of geographical knowledge during the year 1876 has not been marked by any very striking discovery, a large number of valuable details have been accumulated in comparatively unknown localities. As maps become more complete and communication with distant countries is improved, the necessity for exact information becomes more and more urgent. The result is to give to geographical investigations a more exact and scientific method. This tendency is very evident in the expeditions of various nations recently fitted out.

THE UNITED STATES.

As in former years, the results of the government exploring and surveying expeditions in United States territory are eminently interesting and satisfactory.

The work of the English and American Commission for marking the boundary-line along the 49th parallel of latitude from the Lake of the Woods to the Rocky Mountains, generally known as the Northern Boundary Commission, has been brought to a close, and the reports to the respective governments, with maps of the country adjacent to the boundary on both sides, will be very shortly published.

The astronomers and topographers attached to the U. S. Commission were officers of the U. S. Engineer corps, and their labors have greatly added to our knowledge of the barren and dreary country through which the boundary passes. Between the Lake of the Woods and the Rocky Mountains forty-one astronomical stations were established, and the boundary was marked by permanent monuments.

Reconnaissances were made north and south of the line, so as to thoroughly explore the country, to a distance of twenty miles to the northward and one hundred miles to the southward of the boundary. All trails which were passed over outside of the belt of accurate survey were approximately surveyed.

The longitude of Pembina, on the Red River of the North, was determined by the telegraphic method of exchanges with Chicago, and a meridian line was traced with great care from a point on the line six hundred and sixty miles west of Pembina to the vicinity of Fort Shaw, where it was intended to observe the longitude by telegraphic exchanges with Salt Lake; but this plan was frustrated by the bad condition of the telegraph line in Montana, which in 1875 was broken in many places.

The trails thus reconnoitred were from the crossing of the Mouse River *via* Fort Totten to Fort Seward on the Northern Pacific Railroad; from the Missouri at Fort Buford to the boundary, along the two branches of the Poplar River, the meridian trail to Fort Shaw, the Riplinger road along the base of the mountains from the boundary to Fort Shaw, the trail from Fort Buford to Fort Benton, and from Fort Benton to the Sweet Grass Hills. In addition, a reconnaissance of the Missouri River was made while descending that stream in boats, after completing the field-work for the season, in September, 1874.

This reconnaissance demonstrated that the generally received estimate of the distance from Fort Benton to Bismarck is too great by about 400 miles, the survey fixing it at 805 miles.

The country for forty-five miles west of the Lake of the Woods was found to be an immense tamarack swamp only passable when frozen, and necessitating that part of the survey to be made in winter. This was done with some difficulty, the temperature falling as low as 51° below zero. From this swamp to the treeless valley of the Red River the country is woody and somewhat broken. Of the country to the westward of the Red River very little was previously known. From this stream prairie land extends westwardly for thirty-five miles, the boundary then meeting the first steppe, an ancient shore-line, now called Pembina Mountain, much broken with ravines and gorges, through one of which, 850 feet deep, the Pembina River flows. After crossing this river the land ascends to the upper plateau, about 1500 feet above the sea-level, forming the commencement of the Great Plains, which extend for 700 miles to the base of the Rocky Mountains. These plains are in some places quite level, in others undulating, with numerous hillocks, sometimes 80 or 100 feet in height.

A clayey soil, with some admixture of sand, supports the short, wiry, and very nutritious buffalo grass. The first section of these plains east of Turtle Mountain is seventy miles wide, and is almost devoid of rainfall. Over it are scattered great boulders of granite and limestone from a glacial drift. In crossing Turtle Mountain, a curiously elevated and wooded district thirty-five miles wide, the boundary crossed sixty-five pieces of water, of which twenty-five are true lakes. The effect of this wooded area is very marked in attracting rainfall, while the surrounding plains are suffering from drought.

For a distance of 188 miles west of Turtle Mountain the Great Plains continue at an average elevation of 2000 feet above the sea, the only break in the monotony being the valley of the Mouse River, one or two miles wide, and 150 feet deep. The boundary then crosses the second prairie steppe, called the Great Coteau, leading to a plateau about 2250 feet above the sea, broken up by ridges and hollows in every direction, but having farther to the westward a chain of salt lakes about fifteen miles long. This is the central water-shed of the continent, the Mouse River emptying into the Red River and Hudson Bay, while the watercourses farther on fall into the Missouri River and Gulf of Mexico. Here the "bad lands" begin, having a clayey and barren soil, with a very rugged and broken country extending more than 300 miles along the boundary.

At a point 500 miles west of Red River the country changes to an arid plain of sand, with a little soil. Here buffalo were first met with in great herds, and some fresh-water lakes with good pasture were found.

The arid plain extends from east to west for 150 miles, being crossed by the gorge of the Milk River, 300 feet deep. In the midst of this barren expanse, rising abruptly like a group of islands, is the mountainous cluster called the Sweet Grass Hills, or the Three Buttes, the boundary-line crossing the northern slope.

The peaks of this group are 6800 feet high, and from them the Rocky Mountain range, 150 miles distant, can be seen distinctly on a clear day. After crossing St. Mary's River, the boundary enters the fertile belt extending for twenty-five miles to the base of the Rocky Mountains, which rise abruptly to peaks 10,000 feet above the sea. The mountain region where the boundary crosses it is about twenty-six miles wide, and upon the summit of the water-shed, at an altitude of 6700 feet, is placed the monument marking the western limit of the work of the Northern Boundary Commission, and also the eastern limit of the boundary survey carried from the Pacific side.

The maps constructed from the data obtained by both the United States and the British Commission are upon a scale of two miles to the inch, there being twenty-four sheets in the series. A set of reconnaissance maps, on a scale of eight miles to the inch, will also be published in seven sheets, six of them showing the general topographical outline from the Rocky Mountains to the Lake of the Woods, and the seventh sheet showing the profile along the boundary.

Attached to the British part of the Commission as geologist was Mr. George M. Dawson, of Montreal, whose report (published in 1875) contains a full description of the geology, particularly complete in the discussion of the carboniferous deposit which extends from the Pembina Mountains nearly to the Sweet Grass Hills. His discussion is very valuable, as filling up the gap hitherto untraveled between the line of explorations made by Captain Palliser and Dr. Hector, in 1857, 1858, and 1859, along the Saskatchewan, and those of Professor Hayden and others along the Missouri.

Dr. Elliott Coues, the well-known naturalist, accompanied the

United States Commission in 1873 and 1874, and had unusual facilities in making collections in Natural History and Botany. These collections are now deposited in the Smithsonian Institution, and his report will form a separate volume.

The labors of the parties belonging to the "Geographical Survey of the Territories," under the direction of Professor F. V. Hayden, during the past season, have resulted in completing the survey of the mountainous portion of Colorado, with a belt of Northern New Mexico fifteen miles wide, and a belt in Eastern Utah twenty-five miles wide.

For the summer's work four field parties were organized, each accompanied by a topographer and a geologist, and a large amount of geodetic, topographical, and geological work was done, the details of which will be found in the body of the present work.

Six sheets of the Physical Atlas of Colorado are nearly ready for issue, covering an area of 70,000 square miles. The maps are constructed on a scale of four miles to the inch, with contour lines at intervals of 200 feet.

The United States Geographical Survey west of the 100th meridian, under the command of Lieutenant G. M. Wheeler, U. S. Corps of Engineers, has been prosecuted energetically, both as to field-work and in the arrangement and reduction of the mass of material accumulated. A detailed account of the results accomplished will be found in the body of this work.

Under the direction of Professor J. W. Powell, the exploration of the Rocky Mountain region has been carried on, as in previous years, under the auspices of the Secretary of the Interior. A large amount of triangulation and plane-table work was accomplished by the two topographical parties, which were separated from the geological parties, contrary to the custom heretofore. This method of operation gave increased facilities to both branches of the survey. An account of both topographical and geological work is published in the body of the work.

COSTA RICA.

The results of various surveys have been united by Mr. Friederichsen, Secretary of the Hamburg Geographical Society, in making an excellent map of the republic of Costa Rica. The map is on a scale of $\frac{1}{500000}$, or about 8¼ inches to a degree, and is far superior to any heretofore published of that country.

BRAZIL.

In a memorandum prepared to accompany a physical map of Brazil for the United States Centennial Exhibition, Señor Homem de Millo calls attention to the gross errors continually made heretofore in the representation of the mountain and river systems of the empire of Brazil.

The labors and investigations of Baron de Eschwege, Spix and Martins, Saint-Hilaire, and more recently Mr. Liais and Professor Hartt, afford material for a correct knowledge of the physical geography. The surveys made for railway lines have afforded valuable data, and very numerous astronomical observations for position and barometric observations for heights have been made. The results of all this work have been carefully embodied in a physical map, so that no excuse will remain for such gross inaccuracies as have existed heretofore.

PERU.

The first volume of the great work on Peru, by Don Antonio Raimondi, has been published. By this accomplished geographer and naturalist, Peru has for the first time been scientifically explored, Señor Raimondi having devoted a lifetime to the work. More than a quarter of a century ago he made his first journey from Lima across the Andes, and for nineteen years traveled over the country on a fixed plan, diligently collecting materials before beginning to preface his work for publication. The work will consist of six parts, the first being devoted to geography and meteorology, the second to geology, the third to mineralogy, the fourth and fifth to botany and zoology, and the concluding part to ethnology. The work is being published at the expense of the Peruvian government.

From observations made during a recent examination of Lake Titicaca, Peru, Mr. Alexander Agassiz concludes that within a comparatively recent time the Pacific Ocean extended through gaps in the Andes and formed an internal sea, the bottom of which is now at a height of 2900 or 3000 feet above sea-level. This is proved by the existence of coral limestone, similar to the West India formations at about this height, about twenty miles inland from the Pacific. Mr. Agassiz has prepared for publication a valuable hydrographic map of the lake from information obtained during his visit in 1875.

URUGUAY.

In the *Democracia* of Montevideo has appeared an excellent series of letters by Señor Clemente Barrial Posada, the geologist, describing the geology and geography of the interior of Uruguay. Taken in connection with the reports of Mr. Twite's mineralogical explorations in the province of Minas in 1875, these form valuable additions to our knowledge of Uruguay.

BUENOS AYRES.

The government of the Argentine Republic has commenced the publication in German and French of a physical description of that country by Dr. H. Burmeister, who has resided there for the past twenty years, and whose reputation as a geographer is a guarantee of the accuracy of his work.

PARAGUAY.

Our knowledge of the physical geography of Paraguay has been very much increased by the observations of Keith Johnston, Esq., and Lieutenant Congreve, R.N., during their extensive journeys in that country in 1874, notes of which were published in the Proceedings of the Royal Geographical Society in August last, and in the *Geographical Magazine* for September. Careful barometric and boiling-point determinations of heights were made at numerous places, being in all cases referred to the height of Asuncion above sea-level as a base, this being first ascertained with great care, and found to be 321 feet, instead of 258 feet, as heretofore supposed. The exact geographical position in latitude and longitude of about twenty points in the Argentine Republic and Paraguay have been fixed under the direction of Dr. Gould, of the Cordoba Observatory, the longitude being in all cases ascertained with reference to Cordoba by the exchange of time signals over telegraph lines. This work, which is being extended by Dr. Gould as fast as practicable, and which already includes Valparaiso on the Pacific and Montevideo on the Atlantic coast, will be of immense service in rectifying errors in maps already existing, and in furnishing bases for new surveys and explorations.

BOLIVIA.

In Bolivia valuable work is being done by Commander Musters, R.N., and Mr. Minchin, a civil engineer employed by the government in fixing the positions of important places, and in constructing maps of Bolivia. All the longitudes are referred to that of Sucre, the capital, a secondary meridian being established there 65° 17′ west of Greenwich. A scale of fifteen inches to a degree has been selected for their maps; and as the best now existing (made by Colonel Ordasa) is very erroneous, the work now being done will be of great value.

Besides numerous astronomical observations for latitude and longitude of important points, very many hypsometric and magnetic observations have been made.

The discovery, in Sept., 1876, of the rich silver deposits in the mining district of Caracoles, and the immensely rich guano beds of Mejillones, have attracted much attention to the hitherto unknown coast region of Bolivia. In Petermann's *Mittheilungen* for Sept., 1876, Dr. Hermann Wagner has well described this coast district, with the three great western terraces of the Bolivian Andes. Here as elsewhere the searches for practicable railway routes have added much to geographical knowledge.

EUROPE.

The Geographical Society recently founded in Madrid has resolved to devote its energies to the study of the Spanish peninsula and of Spanish maritime possessions, the delineation of which on modern maps and charts is in a lamentably imperfect condition.

In the *Anuario del Observatorio de Madrid* for 1876 is published a notice, by Señor Miguel Merino, of all the most important voyages and geographical discoveries from the earliest time, commencing with the somewhat apocryphal date of the Deluge, B.C. 2400. Since the eighth century of the Christian era the work appears to have been done with great care, the discoveries of the Spanish and Portuguese navigators in the fourteenth and fifteenth centuries having received especial attention. The work deserves the notice of everybody interested in the annals of maritime discovery.

During the past year the government survey of Austria and Hungary has made marked progress. Nearly 150 sheets of the maps, on a scale of $\frac{1}{75000}$, are published or nearly ready for publication. A large number of places have had their longitude determined by telegraph; the exact longitude of Vienna, to which they are referred, being measured directly by telegraph from Greenwich. The Austrian Military Geographical Institute has also published a map of Bosnia, Herzegovina, Servia, and Montenegro in 132 sheets, on a scale of $\frac{1}{300000}$.

An important contribution to the history of geography has been made by the publication, under the auspices of the Royal Italian Geographical Society, of a bibliography of all geographical works, both books and maps, in the Italian language, with a biographical notice of all Italian explorers and geographers.

In no way is the increased interest in scientific geography shown more strongly than in the constant accessions to geographical societies already established, and in the formation of new ones. In Belgium and in Denmark during the past year new societies have been established under very promising auspices.

ICELAND AND GREENLAND.

Under direction of the Danish government, M. Steenstrup, a nephew of the eminent geologist of that name, accompanied by Lieutenant Holm, of the Danish navy, has sailed for Greenland, to commence the exploration of the district of Julianshaab and the interior east of that point. The first authoritative work on Greenland in the English language has been recently published. It is the work of Dr. Rink, for twenty years governor of South Greenland, and is one of the most valuable contributions to arctic geography which has been published for many years.

A Danish expedition has proceeded to Iceland, to explore, among other localities, the vicinity of the recent volcanic eruption. Professor Jonstrup, M. Fieldberg, surveyor, and M. Gronlund, botanist, have accompanied the party. In a paper before the Royal Geographical Society, Mr. W. L. Watts has given an account of a journey to the Iceland glaciers, and stated that these glaciers are manifestly increasing in size from year to year, and, unless checked by a succession of warm seasons, seem likely to overwhelm the island.

ASIA.

In exploration, as well as in the publication of the results of previous travels, a great deal has been done during the past year toward increasing our knowledge of Asiatic geography. In this work the Russian Geographical Society has been energetic, several important expeditions having been, under its auspices, during the past year, either undertaken, continued, or brought to a conclusion. The most important of these, as well as the explorations carried on by travelers of other nations, may be briefly noticed.

The work of carrying a series of levels across Siberia from the European frontier to Irkoutsk, a distance of 2000 miles, under the direction of Colonel Tillo, has been completed, and the results will be shortly published.

The Olena expedition, in addition to the work noticed in the last *Record*, has, under command of the late M. Chekanovsky, explored the Lena and Olonek Rivers, and has examined the great northern *tundra** of Siberia. This appears to be essentially different from the marshy tundra of Western Siberia.

In addition to his geognostic and route surveys, M. Chekanovsky brought home a paleontological collection comprising 1600 specimens, all belonging to the secondary geological epoch, a herbarium containing more than 3000 plants, and an entomological collection numbering more than 7000 insects.

The shores of the Aral Sea and its affluent the Amu-Daria River have been surveyed by a Russian party, and careful magnetic, meteorological, and astronomical observations have been made. An important addition to the knowledge of this region has been made by the publication of "The Shores of Lake Aral," by Major Herbert Wood.

By direction of the Russian Minister of Public Works, M. Sidensner has visited Western Siberia, to ascertain the practicability of uniting the great river systems of the Obi and the Yenisei. He found that the Ket, an important branch of the Obi, afforded the greatest facilities for this undertaking, while his colleague, M. Lopatin, explored the geology of the basin of the Chulim, where he found iron ore. His researches further resulted in the discovery of animal and vegetable fossil deposits in several places on this river.

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* By the word *tundra* are denoted the immense plains in Russia and Siberia between the forest region and the Polar Sea. The ground, though almost every where continually frozen at a short distance below the surface, produces in summer a scanty vegetation.

An important step in the exploration of Central Asia has been made by the expedition to Hissar under the direction of M. Mayef. The party started from Karshi, in Bokhara, passing the Chakcha Valley and the famous gorge known as the Iron Gate, near Darband. This place had not been visited by Europeans since Clavijo's embassy to the court of Tamerlane in 1404. They visited the towns of Hissar and Faizabad, but were prevented by illness among the party from advancing, as had been intended, to the point of confluence of the Wakhsh and Panj Rivers, so as to fix its position astronomically. The maps, when published, will be of great interest.

The remaining unsurveyed portion of the Usboi, or old bed of the Oxus, has been explored and mapped by an expedition under direction of the Caucasus section of the Russian Geographical Society.

At a meeting of the Russian Geographical Society, March 15, 1876, M. Sosnovsky gave an account of his recent journey through China and Mongolia, by order of the Russian government, with the object of opening new markets for Russian trade with Asia, and exploring the route from Zaisang through Dzungaria and the province of Scechnen. The party set out from Kiakhta for Pekin, and reached Hankow in October, 1874. From here they ascended the Han-kiang River, and, after traveling 800 miles by water and 1900 by land, arrived at Zaisang, October 26, 1875, by way of Hanchung, Hami, Barkul, and Guchen. This route can not but be of the utmost importance as soon as a railway shall have been built as far as Tiumen and steamers navigate the Irtish River.

During M. Sosnovsky's journey the position of twelve points was determined by astronomical observations, complete series of magnetic observations were made at ten places, and the altitudes of numerous points determined by barometer or by boiling-point.

An account of the explorations by Lieutenant-Colonel Prejevalsky, during 1870, 1871, 1872, and 1873, in Mongolia and Northern Thibet, has been published during the past year. During the three years' work his party traveled more than 7000 miles, about half of which was laid down in routes surveyed for the first time. Numerous observations by barometer and boiling-point were made for altitude, and the route surveys were checked by eighteen determinations of latitude. The collection of plants, birds, animals, fishes, and insects was very large and valuable, many of the species being new.

Colonel Prejevalsky has commenced another journey through Turkestan and Thibet, the results of which will probably be also of great value. His party started from Kulja on the 22d of August, 1876, and, crossing the Thian-Shan Mountains, will proceed by way of Karashah to Lob-Nor Lake, where they will spend the winter. He will proceed to Lhasa, and explore the upper course of the Brahmapootra, the northern slopes of the Himalayas, Eastern Thibet, and Southwestern China, returning if possible to Russia by way of Western Thibet and Kashgar. The expedition will make geographical and ethnographical researches, and a route survey. Positions will be determined astronomically, and collections made in all branches of natural history.

A survey of the coast of Eastern Siberia between the parallels of 45° and 52° N. has just been completed by Lieutenant-Colonel Bolschef. The undertaking was a very arduous one, as there is no land route along the coast, and in-shore navigation is always dangerous and frequently impossible, owing to the shelterless character of the coast and the heavy surf constantly beating upon it. The country is well watered, fertile, and heavily timbered. The fisheries are very productive and the mineral wealth is great: lead, silver, iron, copper, coal, and gold having been found.

An interesting report by Colonel Bolschef of the general results of this survey is contained in the July number of the *Isvestia* of the Russian Geographical Society,

A German expedition has been engaged during the past year in the exploration of Northern Siberia, under the leadership of Dr. Finsch, accompanied by Dr. Brehm and Count Waldburg-Zeil, of the Bremen *Polar Verein*. The details of their journeys are not yet published, but the expedition has returned to St. Petersburg after a successful summer's work. No less than seven additional scientific expeditions have been engaged in the exploration of Russian Asia, under the auspices of various Russian learned societies.

Petermann's *Mittheilungen*, Supplement No. 46, contains a valuable memoir on the Pekin plain and the neighboring mountain-land, by Dr. Breitschneider, being the results of observations during nine years while the author was serving as physician to the Russian embassy. His account of Pekin and its vicinity tends to confirm the reports of Marco Polo. Dr. Breitschneider affirms that, instead of one or two millions of people, from his own intimate knowledge of Pekin, its population does not exceed at most 500,000.

In the *Bulletin de la Société Géographique* the Abbé Armand David gives an interesting account of his travels in Western China from 1868 to 1870. His object was to ascend the Yang-tse River, and penetrate through the province of Sz-chuen into Thibet. In this he was disappointed, principally owing to ill-health, but his exploration of the Yang-tse affords much information of value as to the course of this great river and its tributaries.

In India the work of the great Trigonometrical Survey has been energetically carried on under the superintendence of Colonel Walker, R.E. An appendix to Colonel Walker's report for 1874 consists of the report, by Captain H. Trotter, R.E., on the secret journeys of Indian employés of the survey in trans-Himalayan regions. Under various pretexts and disguises, these officials, known as the Havildar, the Mollah, and the Pundit, have traversed hitherto unknown regions, and have collected a mass of data, the results of which have been an immense gain to the geography of these regions. In the *Geographical Magazine* for January, 1877, will be found a sketch of the work performed during 1875.

The *Geographical Magazine* for October, 1876, contains an interesting article on the authorities used by Major St. John in constructing his map of Persia, in six sheets, on a scale of sixteen miles to an inch. His map exhibits solely the information derived from trustworthy European sources. A vast amount of information embodied in it is published for the first time, and the map is considered to be of the highest value.

The geographical results of a survey made in 1872 and 1873 of the routes for a railway to join the Mediterranean and Persian Gulf are published in a supplement to Petermann's *Mittheilungen*. The survey was made under the direction of Mr. Josef Cernik, who arrives at the conclusion that the route through the valley of the Euphrates is impracticable, and recommends a more circuitous line along the base of the mountains of Kurdistan, through Mosul, Diarbekr, and Aleppo to Alexandretta on the Gulf of Iskanderun, or Tarabulus on the Black Sea.

The amount of country surveyed in Palestine by the English expedition for that purpose during the past year is 1500 square miles, making a total of 3500, and leaving about 1400 square miles in Upper Galilee to be completed. A line of levels between the Sea of Galilee and the Mediterranean was commenced, but was interrupted by the hostility of the natives. It is hoped that the trigonometrical survey may be completed this year.

In February an expedition sent by the American Palestine Exploration Society, under charge of Dr. Selah Merrill, visited the valley of the Jordan and the eastern shore of the Dead Sea, devoting considerable time to the section at the northeast corner of the Dead Sea and the mounds that exist there, with reference to the geography of portions of the 13th chapter of Joshua and the 32d chapter of Numbers.

AFRICA.

The details and results of the journey of Lieutenant V. L. Cameron, R.N., across Africa in 1873, 1874, and 1875, have been published during last year, and entitle him to very high rank as a scientific explorer. The original object of the journey being to search for and succor Dr. Livingstone, the expedition commanded by Lieutenant Cameron left Zanzibar for the interior in March, 1873, and upon hearing, in October of the same year, of Dr. Livingstone's death, pushed on to Lake Tanganyika, to secure the effects of the deceased explorer at Ujiji. This he succeeded in doing; and taking such instruments of Livingstone's as were needed to replace those lost and injured during his journey from the coast, Lieutenant Cameron prepared for his western journey. After examining a portion of the shores of Lake Tanganyika, he turned to the northwest and reached Nyangwé, an important commercial town, in south latitude 4° 12′, east longitude 26° 31′, in the autumn of 1874. Careful astronomical observations were made here to determine a starting-point for further exploration, Lieutenant Cameron's intention being to follow the banks or valley of the Lualaba River, an affluent of Lake Tanganyika, so as to prove its identity with the Congo; but this was found, from want of boats and from native hostility, to be impracticable, and he was obliged to pursue a more southerly track. Having proceeded as far as the tenth degree of south latitude, Lieutenant Cameron turned to the westward, and, passing along the water-shed between the tributaries of the Congo and the headwaters of the Zambesi, arrived after much delay and trouble, on November 4th, 1875, at the Portuguese settlement of Benguéla, on the western coast. Among the most important of the discoveries during this long journey was that of a hitherto unknown but extensive water system, formed by a river flowing through a series of lakes intermediate between the Lomamé and the more eastern valley which Dr. Livingstone had followed up from Lakes Bangwealo and Mœro. The whole country between Nyangwé and Lake Dilolo, a distance of over 600 miles, is new ground, as, although the Lulua, the Luburi, and other rivers crossed by Lieutenant Cameron had been heard of before and the country had been traversed, he was the first to fix their true position on the map. He ascertained that at Nyangwé the Lualaba River is only 1400 feet above the sea, proving that this great water system can have no connection with the Nile, that river being at Gondokoro 1500 feet above sea-level. There seems to be no reasonable doubt that the Lualaba and the Congo are identical. The information collected by Cameron explains a great deal of Dr. Livingstone's memoranda which would otherwise be unintelligible.

One of the principal geographical results of the journey has been the construction of a section of elevation across the entire continent of Africa between the fourth and twelfth degrees of south latitude, verified throughout by careful astronomical observations. Lieutenant Cameron's diligence and skill in taking observations (over 5000 being made for latitude, longitude, and elevation), and the general success of the journey, have earned for him his promotion in the Navy to the rank of Commander, and the award of a gold medal from the Royal Geographical Society.

The expedition sent out by the German African Society to penetrate into the interior from the west coast has not thus far been very successful.

Dr. Otto Lenz, who had hoped to follow the course of the Ogowé River, and who had so far succeeded as to overcome the opposition of the inhabitants of the Oscheba lands, has been obliged to return to Europe in consequence of ill-health. The only remaining members of the expedition, Dr. Paul Pogge and Mr. Edward Mohr, are exploring the Angola coast, which is to serve as the starting-point of their respective journeys.

An expedition under command of Count Pietro di Brazza, and conducted at his own expense, has commenced exploration by way of the Ogowé River. The party started from Gaboon, and was furnished by the French authorities there with an escort of seventy colored soldiers. The party had at last advices succeeded in penetrating to Okanda, 500 miles from the mouth of the Ogowé River. This place will be used as a starting-point for explorations into more unknown regions.

Colonel Gordon, R.E., who has been engaged in the exploration of the Upper Nile, has been most persevering in his efforts to find a navigable channel to the Albert and Victoria N'yanza. Proceeding up the Nile with a portable steamer and boats, progress was stopped by the Tola Falls or Rapids in about 4° north latitude. He therefore left the river and proceeded by land to the Victoria and Albert N'yanza, taking possession of both lakes for the Khedive of Egypt. Then returning to Dufflé, above the rapids, he found the steamer and boats, which had been carried piecemeal by the falls, and dispatched M. Gessi up the river to the Albert N'yanza, which was entered and circumnavigated, and found to be one hundred and forty miles long and fifty miles wide. An ineffectual attempt has been made to find among the numerous diverging branches of the White Nile some stream which may carry boats round the Tola Rapids. As all these branches have not been examined, Colonel Gordon thinks that water communication between Khartoum and the Victoria N'yanza may be established.

The circumnavigation of Lake Nyassa by Mr. E. D. Young has been accomplished, and the discovery made that the lake extends 100 miles farther north than was supposed by Dr. Livingstone. No bottom was found with 100 fathoms of line. A further examination of the lake and of its shores will be made.

Mr. H. M. Stanley is still pursuing his explorations in Central Africa, but no precise details of his travels since the publication of the *Record* for 1875 are available to determine what additional geographical information has been collected.

A large portion of Mr. Stanley's labor has been devoted to the exploration of the country hitherto unknown between the two lakes Victoria and Albert N'yanza.

A geographical conference regarding the exploration of Africa took place at Brussels, September 12th, and was attended by numerous African explorers as well as eminent geographers from several European states. The conclusions arrived at were in general that stations should be established on the coast and in the interior available to explorers as bases to start from.

It is intended to limit the field of international exploration to the region bounded on the east and west by the Indian and Atlantic Oceans, and on the north by the frontiers of the Egyptian territory and independent Soudan.

AUSTRALIA.

An account has been recently published of explorations made in Southern and Western Australia in 1875 by Mr. Ernest Giles, already distinguished in Australian discovery. The expedition started July 27, 1875, from Youldeh dépôt, 185 miles N.N.W. from Fowler Bay, near the border of the known region of South Australia. The first important discovery was the well of Oldabinna, an open space in the scrub bush which surrounds it. Moving westward from this place an utterly waterless country was entered upon covered with dense bushes. Five hundred miles were traversed before any water was obtained, and the region was utterly uninhabited by man or animal. After passing this desert another was traversed, after which a region occupied by hostile natives was crossed, the expedition finally arriving in November at Perth, Western Australia. The whole journey covered 2500 miles, in which not one area fit for settlement was found. The line traversed lies between the route of Eyre in 1840 and Forrest in 1870.

Mr. Giles has during the winter season of 1876, from April to August, accomplished a return journey, during which he traced the Ashburton River to its sources, and determined the water-shed of the western rivers, which he describes as simply a mass of rangy country, abutting upon the desert in east longitude 120° 20′. No watercourses were found to flow eastward from the end of the water-shed in that longitude. During the journey the longest time the party were without finding water was ten days. They experienced an excessively cold winter, the thermometer in the morning being for weeks down to 18°.

NEW GUINEA.

The shores of New Guinea have continued to afford subjects of interest to the explorer and naturalist. At the expense of the Genoese authorities, Signor Odoardo Beccari has been engaged for some years past in explorations in this vicinity, and has completed an important geographical work. In exploring the coast of Northwestern New Guinea he has discovered a river called Wa Samson, flowing from east to west for a distance of 215 miles, and affording the principal drainage of this part of New Guinea. He has also examined Geelvink Bay, which separates the northwestern peninsula from the mainland, and has made an important rectification of its coast-line on the charts, shifting it to the northward in some places as much as thirty miles. Until Signor Beccari's visit, the hydrography of this part of the island was based on an old Dutch chart of 1705.

The Fly River has been explored by Mr. S. Macfarlane, accompanied by the Italian naturalist, Signor D'Albertis, in a steamer to a distance of 150 miles from the mouth. This is the first positive knowledge that the river is really navigable, and Mr. Macfarlane considers it probable that they could have proceeded much farther but for fevers which attacked nearly all the party. The land was low and swampy, and the population scattered.

Signor D'Albertis proposes to revisit this vicinity and explore the Fly River to the head of navigation, and from that point to cross the country to Yule Island. The Chamber of Commerce of Sydney have undertaken to assist him, and have furnished him with a steam launch.

Mr. Octavius Stone, one of the explorers of the Baxter River, has been continuing his labors from Port Moresby to the eastward of the Papuan Gulf. The low country of the coast seemed to be bare, luxuriant vegetation only being found where the mountain ranges rise and intercept the rainfall. Mr. Stone, in a recent communication to the British Association, remarks that the neighborhood of the Baxter River and the shore west of the Papuan Gulf for 100 miles inland are swampy, covered with mangrove trees, and thinly populated. The climate of the western coast is peculiarly fatal to Europeans, but the eastern peninsula is warm and healthy.

Dr. Miklucho-Maklay is engaged in exploring the group of little-known islands lying between New Guinea, New Ireland, and New Britain.

HYDROGRAPHY.

By Lieutenant-Commander F. M. Green, U. S. N.

The most strongly marked feature of hydrographic work for the past year is the careful exploration of the depth and temperatures of the sea, and of the nature of the bottom. Americans, English, Germans, Norwegians, and Chilians have all added much to our knowledge in this direction.

The United States Coast Survey has done valuable work of this kind in the Gulf of Mexico, where very numerous soundings and temperature observations have been made to determine the contour of the bottom and of isothermal surfaces. In addition, the work of completing the hydrography of those portions of our coasts not yet thoroughly examined, and of re-examining the localities liable to change, has been diligently prosecuted.

On the Atlantic coast surveying work has been done at Deer Island and Saco Bay, on the coast of Maine; on the coast of New Jersey, in Delaware Bay, in Albemarle and Pamlico Sounds, on the coasts of South Carolina, Georgia, and Florida, and on the Florida Reefs.

On the Gulf coast extensive work has been done on the coasts of Florida and Louisiana, including observations of currents, volume of discharge, differences of level, changes of depth, etc., at the mouths and bars of the Mississippi River.

On the Pacific coast the survey of the coast-line of Northern and Southern California, as well as that of Oregon and Puget's Sound, has been carried on.

In the prosecution of these surveys nineteen parties have been engaged on board of the same number of small vessels, nine of this number being steamers and the rest sailing-vessels.

The work of compiling a "Coast Pilot," or sailing directions for the Atlantic coast, has also steadily progressed.

The United States Hydrographic Office has continued the routine work of exchanging hydrographic information with foreign hydrographic offices, and of publishing promptly all notices which might be of use to our mercantile and naval marine. From the hydrographic offices of England, France, Germany, Italy, Russia, Spain, Austria, Denmark, Sweden, Portugal, Holland, Brazil, and Chili, information as to dangers discovered, or as to the establishment of aids to navigation, has been constantly received, translated, and examined, while to these governments, as well as to chambers of commerce, marine insurance offices, and prominent newspapers at the principal ports, all such information coming to the knowledge of the office is communicated. Seventy-five notices to mariners, embodying information of changes in artificial aids to navigation, have been published, as well as sixty-nine hydrographic notices of newly discovered features in the earth's surface.

As far as the limited appropriations made by Congress would permit, new charts have been engraved and published.

Sailing directions for the Pacific Ocean, the west coast of Africa, a part of the coast of the Mediterranean, the Bay of Biscay, the West India Islands, and for the coasts of Chili, Peru, and Bolivia, have been published during the past year, or are ready for publication.

Under direction of the Navy Department, the U. S. steamship *Tuscarora*, Commander J. N. Miller, has examined the depth of the Pacific Ocean from the Sandwich Islands to the Fiji group, and thence to Brisbane, Australia; to determine if the laying of a telegraph cable is feasible from California to Australia. In the performance of this work one hundred and seven soundings were made with steel wire. Specimens of the bottom were obtained from nearly every sounding, and are now being examined. Of these soundings the deepest was 3448 fathoms; there being nineteen of less than 1000 fathoms, thirty-eight of from 1000 to 2000 fathoms, thirty-two from 2000 to 3000 fathoms, and eighteen of over 3000 fathoms.

The observations for the determination of secondary meridians in the West Indies have been completed by the officers of the U. S. steamship *Gettysburg*.

The undertaking of systematic determinations of longitude by the electric telegraph, wherever submarine cables extend, thus commenced by the U. S. Navy Department, has received much attention and commendation from foreign officers.

During the homeward voyage of the *Gettysburg*, deep-sea soundings were made in the intervals between those previously made by H. B. M. steamship *Challenger*, in every case confirming the *Challenger's* work.

In consequence of errors known to exist in the geographical positions of the north coast of South America, the U. S. steamship *Huron* has been ordered to determine the longitudes of about thirty stations along that coast, measuring the longitudes by chronometer from the meridians of Port Spain (Trinidad) and Aspinwall, previously determined with great exactness by telegraph.

The U. S. steamship *Gettysburg*, while engaged in searching for doubtful dangers in the eastern part of the North Atlantic Ocean, has discovered a remarkable coral bank, about five miles in extent, lying about one hundred and thirty miles to the westward of Cape St. Vincent. The least water found on the bank thus far is thirty-four fathoms, but there is probably less.

The English have as usual performed by far the largest portion of the hydrographic work of the past year. Under the direction of the British Hydrographic Office, surveys of a permanent character are being carried forward on the shores of England, Ireland, the Gulf of St. Lawrence, Newfoundland, Labrador, Jamaica, Mauritius, the east coast of Africa, Japan, Australia, and the Fiji Islands, while detached surveys have been made in the Mediterranean, on the coasts of China, and among the Pacific islands. Interesting results have been derived from the examination by British surveyors of the Mediterranean entrance of the Suez Canal, the approaches to which do not seem to have shoaled as much as was anticipated.

Since the publication of the *Record* for 1875, the admirable work done by the English surveying-ship *Challenger* has been brought to a close by her arrival at Spithead on the 24th of May, 1875.—Resuming the sketch of her cruise where it was left in the *Record* for 1875, the ship, after refitting, left Yokohama on the 11th of May, 1875, for a short cruise of about three weeks to Kobe and the Inland Sea, where some dredging was done, but without much success. The expedition finally left Japan on the 16th of June, and, constantly dredging and sounding in depths of from 1875 to 3950 fathoms, arrived at Honolulu, Sandwich Islands, on the 27th of July. The soundings between Japan and the Sandwich Islands were quite uniform in depth, the average of twenty-two being 2858 fathoms. The bottom was generally red clay, frequently filled with concretions of peroxide of manganese from the size of a grain of mustard seed to that of a large potato. These concretions were formed by concentric layers, starting from a nucleus consisting of some foreign body like a shark's tooth or a bit of pumice.

On the 11th of August the *Challenger* proceeded to the island of Hawaii, where the volcano of Kilauea, then in eruption, was visited, and good photographs were obtained of it. On the 19th of August the ship sailed for Tahiti, arriving there early in September. Many soundings and dredgings were made on the way, with an average depth of 2800 fathoms; the bottom being generally of red clay, and many things of great interest to the biologist being discovered.

Leaving Tahiti on the 2d of October, Juan Fernandez, at a distance of 4000 miles, was reached on November 13th, the section between the two places having an average depth of 2160 fathoms.

From Juan Fernandez the *Challenger* sailed for Valparaiso, sounding, trawling, and taking serial temperatures constantly. From Valparaiso the homeward voyage was commenced on the 11th of December, *via* the Strait of Magellan, where some valuable additions were made to the naturalists' collections, the ship reaching Port Stanley, Falkland Islands, January 23d. While here, magnetic observations were made at the exact spot where Sir James Ross's magnetic observatory was established in 1842, when it was discovered that the inclination of the magnetic needle had changed from 48° 26′ in 1842 to 52° in 1876.

Leaving the Falkland Islands on the 6th of February, the *Challenger* proceeded to Montevideo, then to Ascension, Porto Praya, St. Vincent, and Vigo Bay, the work of sounding, dredging, and taking serial temperatures being steadily and faithfully kept up. From Vigo the ship sailed for England, arriving at Spithead on the 24th of May.

During this long and admirably conducted cruise the *Challenger* sailed and steamed more than 69,000 miles. Nearly 400 deep-sea soundings were made, of which two were over 4000 fathoms, nine between 3000 and 4000 fathoms, one hundred and sixty-eight between 2000 and 3000, one hundred and twenty-four between 1000 and 2000, and the remainder were under 1000 fathoms. Serial temperatures of the ocean were obtained at 250 stations, and dredging was effected at nearly as many. In addition to this work done at sea, very many anchorages were surveyed, and numerous additions and corrections made on the charts of the coasts visited.

H. B. M. S. *Valorous*, after parting from the arctic ships *Alert* and *Discovery* on the 17th of July, 1875, and stopping *en route* at Holsteinborg, returned to Cork. During the three months' cruise of the *Valorous*, in addition to the chief duty of supplying the Arctic Expedition, much valuable hydrographic work was accomplished. No less than fifty-seven deep-sea soundings were made in Davis Strait and the Atlantic; dredgings which have yielded important results were made in hitherto unexplored regions;. valuable observations of temperatures at different depths were made; and several harbors, including Holsteinborg with its approaches, were surveyed. The Atlantic soundings indicate that there is a cap or ridge with only 690 fathoms upon it, and with comparatively steep sides, at a distance of about 400 miles southeast of Cape Farewell.

Upon parting company with the *Valorous* off Disco Island on July 17th, the *Alert* and *Discovery* took their way to the northward, first encountering the ice of the middle pack on the 24th of the same month, but passing through it without difficulty in thirty-four hours. After visiting Port Foulke and Life-boat Cove, the scene of the wreck of the *Polaris*, the ice was met on July 30th off Cape Sabine, and from this point a constant struggle with it took place until August 25th, when, after many narrow escapes from being crushed, the vessels reached a harbor on the west side of Hall's Basin, in latitude 81° 44′ N. Here it was decided to leave the *Discovery*, and she was accordingly secured in sight of Polaris Bay, on the opposite side of the channel. The *Alert* pushed on to the northward, attaining a latitude of about 82° 30′ north, farther than any ship had previously reached, when she was beset by the ice, and, sheltered by some bergs which had grounded in twelve fathoms of water, the ship was secured for the winter about three miles to the northward of the entrance to Robeson Channel. This, although a disappointment at the time, was probably fortunate, as the winter's observation indicated that, had a more northern latitude been attained, the *Alert* would have been so embedded in the ice that no amount of labor would have extricated her. Instead of an open Polar sea, the ice was jammed together in masses of extraordinary thickness like icebergs, in some instances being from 150 to 200 feet thick, doubtless the accumulations of many winters.

Upon its being evident that farther northern progress with the *Alert* was not to be hoped for, the sledge work was commenced with marked promptness and energy, exploring parties being sent from the *Alert* to the north, northeast, and northwest, and from the *Discovery* to the opposite Greenland shore. The sledge parties established dépôts of provisions for the expeditions to be sent out the next spring, but experienced much hardship and suffering. The winter was unusually long, cold, and dark, the sun being absent for 142 days, and the temperature reaching 73.7° below zero, early in March, on board the *Alert*, the *Discovery* at the same time registering 70.5° below zero. Magnetic, meteorological, and astronomical observations were regularly made during the winter, and many expedients were successfully resorted to on board both ships to break the dreary monotony, till, on March 1st, the sun again appeared, and preparation for exploration by sledging parties was begun. By the beginning of April every man, except those absolutely necessary for the care of the ships, had departed, expeditions being sent in every direction, those from the *Discovery* turning their attention principally to the exploration of the western and northern coasts of Greenland.

A party under command of Commander Markham proceeded northward. Their progress was most difficult, owing to the roughness of the ice, but they reached a latitude of 83° 20′ 26″, finding under the ice a depth of seventy fathoms of water. No land was visible to the northward from this point.

To the westward of the *Alert* the coast-line was examined for 220 miles by a party under command of Lieutenant Aldrich, the most northern land found being in latitude 83° 7′ N., longitude 70° 30′ W.

On the Greenland shore, parties from the *Discovery*, under command of Lieutenants Beaumont and Rawson, explored the coast-line to the northeast, the farthest land found in this direction being in latitude 82° 54′ N., longitude 48° 33′ W., apparently almost identical with the Cape Sherman of the American charts. This coast is much cut up with fiords and inlets. Lady Franklin Sound and Petermann Fiord were also examined, the former being found to terminate sixty-five miles from the mouth, and the latter to be blocked up with a low glacier. This examination completes the shores of Smith Sound, except Hayes Sound.

President Land, marked on recent charts as in latitude 84° N., is shown not to exist, the land at the northern entrance of Robeson Channel trending sharply to the westward from Cape Union.

In spite of every precaution the sledge parties suffered dreadfully from scurvy, but showed the utmost fortitude and self-devotion. Fortunately only four deaths took place, three from this disease and one from frost-bite. The prevalence of this malady, and the very clear demonstration that no new discoveries were to be anticipated from protracting the stay of the expedition through another winter, decided Captain Nares to proceed to England as soon as the advancing season should liberate the ships. The *Alert*, however, was bound fast by the ice till July 31st, when a start was made, the *Discovery* being reached after much difficulty and danger. On August 20th both ships commenced their homeward voyage; but it was not till September 9th that, by clearing the ice and reaching open water, a certainty was assured of avoiding another winter in these dreary regions. Both ships reached Queenstown on October 29th, and after a few days proceeded to Portsmouth.

The results of the various observations, physical and meteorological, can not, of course, be known for some time, but will doubtless be very important. Large collections of natural-history subjects were made, among them some fine fossil corals, and the dredge and trawl were used several times with great success.

This is not the place to discuss the general results of the expedition; but its whole conduct is an ample guarantee that, when published, they will be in an eminent degree interesting and trustworthy.

In connection with arctic research, Lieutenant Weyprecht, of the Austro-Hungarian expedition, points out in an address delivered at Grätz, in September, 1875, the advantages which would accrue from the establishment of fixed observatories at various points over detached expeditions, which devote the best part of the year to sledge journeys. Arctic research he considers of the highest importance, but points out that independent series of observations, especially if chiefly devoted to geography, have but little value compared with stationary observatories encircling the arctic lands, and working on synchronous magnetic-term days and other agreed times.

These considerations have been fully presented by the German commission to which the subject was referred, with Lieutenant Weyprecht as a member. The commission also urges that a proper understanding be had between different nations, so that the labor of one party need not be duplicated by another.

An important contribution to arctic discovery is made by the publication, in Petermann's *Mittheilungen*, of the finished map and description of Franz-Joseph Land, discovered by the second Austro-Hungarian expedition in 1873. Hitherto only an outline sketch has been published, but this one is based on the results of Lieutenant Payer's barometric observations for elevation. The land is not unlike Spitzbergen, and is composed of several groups of islands. Franz-Joseph Land exhibits the full rigor of arctic latitudes. In the beginning of spring, especially, every thing is covered with ice.

It is known that Northeast Greenland, Nova Zembla, and Northern Siberia exhibit signs of a slow process of rising from the sea. It was, therefore, very interesting to the voyagers to observe proofs of elevation in well-marked drift terraces. Vegetation is very scanty.

The recently organized Marine Survey of British India, under the superintendence of Captain A. D. Taylor, has been carried on in an energetic manner, a large amount of work having been done in surveying the approaches to Rangoon, Maulmain, the Bassein River, and Akyab.

Several important coast charts have been published, as well as sailing directions for the Bay of Bengal, and a most important series of hydrographic notices have been commenced.

Exceedingly valuable as the results of all these English surveys are, they have been dearly purchased at the cost of the lives of several of the officers making them, four at least in different parts of the world having fallen victims to overwork and the unhealthiness of the climate where their duties led them.

The German Hydrographic Office, although very recently organized, has aided largely during the past year in the collection and distribution of valuable information. The *Annalen der Hydrographie* for the year contain abstracts of the journals of various voyages of German men-of-war, whose commanders have lost no opportunity of deep-sea sounding, correcting charts and sailing directions, or of redetermining untrustworthy geographical positions. Prominent in this work has been the corvette *Gazelle*, a portion of the scientific staff of this vessel being the observers of the transit of Venus at Kerguelen Island. The expedition left Kiel June 21, 1874, and proceeded by way of Madeira, Porto Praya, Monrovia, Ascension, the Congo River, and Cape of Good Hope to Kerguelen Island, sounding, dredging, and taking serial temperatures at sea whenever an opportunity offered. The most remarkable discovery during the outward voyage of the *Gazelle* was that the soundings in the vicinity of the Cape de Verde Islands indicated that the islands form parts of the rim of an enormous submarine crater, similar in form to the crater of an isolated volcano.

During a stay of more than two months at Kerguelen Island, in addition to other work, a hydrographic survey of the northeast coast of the island was made, this vicinity having been almost unknown hitherto.

From Kerguelen Island the *Gazelle* proceeded to Mauritius, and thence to Western Australia, Timor, and Amboyna, constantly making observations at sea of depth, temperature, and currents; and when in port making use of every opportunity of correcting charts.

Leaving Amboyna on the 11th of June, 1875, the northeast coast of New Guinea, with the adjacent islands, was visited and explored; the expedition next visiting Western Australia, New Zealand, the Fiji and Samoan groups. Passing from the Pacific Ocean through the Strait of Magellan, at Montevideo the English exploring-ship *Challenger* was met. From Montevideo the *Gazelle* sailed for home, arriving at Kiel on April 28, 1876. Differing from the famous cruise of the *Challenger* only in extent and duration, the observations made during the cruise of the *Gazelle* promise equally important results.

Within a short time ships of the English, German, and United States navies have determined the exact depth of the ocean in more than 1200 places where it was previously unknown.

The French *Dépôt des Cartes et Plans de la Marine* have published numerous valuable charts and sailing directions, the most important of the latter being a minute description from recent surveys of the island of Guadeloupe. The most important survey made during the past year by French naval officers has been the survey of the shores of the Gulfs of Sidra and Gabes on the north coast of Africa. These shores, between Sfax and Benghazi, have not heretofore been regularly surveyed, owing to the barbarity of the inhabitants and the shelterless character of the coast, and it was with great difficulty that Captain Mouchez, the officer charged with the work, was able to complete it.

The Chilian government have done excellent service by their recent establishment of a hydrographic office, much valuable information having been already collected and published.

The Chilian corvette *Ancud* has made a series of deep-sea soundings between Valparaiso and Caldera, preparatory to the laying of a telegraph cable between these two points. The west coast of South America affords a wide field for hydrographic work, and there is every reason to hope that the work so well begun by the Chilian government will be continued.

Japanese officers have made useful surveys principally of harbors on the coasts of the larger islands of Japan, and also among the off-lying groups to the southwestward, notably at Oösima Island and the Meiaco Sima group.

Many of these surveys are published by the Japanese authorities in a form useful for navigators of other countries.

The Norwegian deep-sea sounding expedition in the *Vöringer* has done good work during the summer. Leaving Christiansund on June 27th, sounding and dredging was carried on between Norway, the Faroë Islands, and Iceland very successfully. The scientific results of the expedition are already considerable; the animal life exhibiting a much greater variety than was expected, although the depths and distribution of temperature were not very different from the anticipations previously formed.

Magnetic observations were made at various points in Iceland and the Faroë Islands.

Under the leadership of the celebrated arctic explorer Professor Nordenskjöld, an expedition has been at work during the past summer having for its main object the survey of the navigable waters between the Obi, Yenisei, and Norway.

This work has been successfully completed, and Professor Nordenskjöld states that the navigability of the rivers may be considered as practically established, and that it is practicable to maintain trade communication between the different portions of the Kara and the Yenisei.

The Kara Sea was found free of ice between September 2d and 7th, and a new island was discovered at the mouth of the Yenisei, in 73° N. latitude, which has been named Sibiriakoff Island. On both sides of it the water is deep and free from shallows, and the island will form a valuable protection against northwest winds and sea.

Professor Nordenskjöld concludes his interesting report of his summer's work by expressing his conviction, shared by the walrus-hunters whom he consulted, that a regular sea communication between Siberia and Northern Europe during a short season of the year ought not to be attended with greater risks and dangers than seamen encounter on many other waters now yearly visited by thousands of vessels.

ANTHROPOLOGY.

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Anthropology is either descriptive or deductive. Descriptive anthropology gives an account of investigations concerning extinct or extant tribes of men. The former study is also called Archæology, and may be either prehistoric or classical; the latter is called Ethnography. Deductive anthropology embraces all discussions relating to mankind, including the study of his geological, zoological, and geographical origin, his primitive and subsequent somatical and psychical conditions and variations, the influence of environment, and the progress of culture. A complete account of the subject would also include a description of the various instrumentalities of research, and apparatus for observation and measurement, an accurate terminology, instructions to observers, a report of local and general meetings and international conventions, and a catalogue of all "transactions," private collections of merit, museums, periodicals, and books devoted to anthropology.

The following summary is arranged upon the order just mentioned; but, to avoid repeating much that has occurred in former volumes of the *Annual Record*, and on account of the limited space allotted to each summary, many of the headings will have to receive a brief consideration.

I. ARCHÆOLOGY.

North America.—Mr. William H. Dall read before the Washington Philosophical Society, January 31st, a long and carefully prepared paper upon "A Succession of Shell-heaps in Alaska." The author found in the mounds three layers, which he named, respectively, the echinus layer, the fish-bone layer, and the mammalian layer; and holds that these represent three grades of culture which have been developed in this region. Adolphe Pinart recently announced to the French Geographical Society his discovery of mounds upon the southern portion of Vancouver Island different from the shell-heaps of the coast.

At the last meeting of the American Association, Mr. G. H. Perkins read a paper upon "The Ancient Pottery of Vermont." At the same meeting, Mr. Henry Gillman made three communications, entitled "Peculiarities of the Femora from Tumuli in Michigan," "Some Observations on the Orbits of the Crania from the Mounds," and "Investigation of the Burial Mound at Fort Wayne, on the Detroit River, Michigan."

The Proceedings of the Davenport (Iowa) Academy of Natural Sciences, Vol. I., covering the period from 1867 to 1876, is a publication worthy of the highest praise. The zeal of the members of the society, and the generosity of its lady friends, are alike commendable. The archæological contributions relate principally to Ohio mounds; and the most noteworthy feature of their relics is the frequency of copper celts, some of which are found wrapped in a coarse cloth.

The archæology of Missouri is discussed in the third volume of the Transactions of the Academy of Sciences at St. Louis.

In the *American Naturalist* for February, Dr. C. C. Abbott defends the existence of a palæolithic and a neolithic age in New Jersey. The shell-heaps are traced back to a period 6000 years before Columbus.

Cave explorations have been made in Pennsylvania by Professor Haldemann and Professor Baird. They have yielded no evidence of the existence of man beneath the stalagmite. Bone implements and fine stone implements have been discovered, and some slight indications of cannibalism.

The mound-builders have been discussed in a pamphlet by Mr. G. S. B. Hempstead, of Portsmouth, Ohio; in contributions to the *Scientific Monthly* of Toledo, by Mr. Charles Whittlesey; and in a paper read by Hon. Lewis H. Morgan before the National Academy, in April, and published in the *North American Review* for July. The last-named memoir is worthy of the cautious and exhaustive pen of our countryman. "The mounds are considered as dwelling sites of 'village Indians.' The embankments, if reformed, would resemble a railway grade with a summit platform. These were the sites of the houses. The buildings were of timber, on the summit of the embankments, thus making a continuous, sloping rampart twenty feet high." Mr. Morgan reproduced in drawings the ground-plan of the structure, and an ideal reconstruction of a mound-builders' village.

Mr. Charles M. Wallace, of Richmond, Virginia, contributes to *Silliman's Journal*, No. III., 1876, an article upon flint implements which the author claims to have found in the stratified drift in the vicinity of that city. Whether they are of human origin or not, they are useful as throwing light upon similar objects found in other places.

The subject of pigmy graves in Tennessee and Kentucky is revived in our popular journals, and we are informed that many intelligent persons still believe in the former existence of such a race. The whole matter is set at rest, however, by the investigations of Jones, Clarke, Haskins, and Troost, a review of whose labors will be found in *Harper's Magazine* for December, 1876.

No. IV., Vol. I., of the Memoirs of the Peabody Academy of Science contains the essay of Professor Jeffries Wyman upon the "Fresh-water Shell-mounds of the St. John's River, Florida." The work of publication was superintended by Professor F. W. Putnam. In addition to the ordinary finds in such localities, some striking facts are elicited. "The mounds contain human bones, broken up in the same way as the bones of edible animals, and are believed to be the remains of cannibal feasts. They contain fragments of the bones and teeth of extinct animals, as the mastodon, elephant, horse, ox, turtle, manatee, and a cetacean. These have undergone changes which show that they were not contemporaneous with the builders of the mounds."

The Ninth Annual Report of the Trustees of the Peabody Museum of American Archæology and Ethnology gives an account of the work done during the year, the report of collections and distributions, and an index to all the volumes of the series. The portraits of Mr. Peabody and Jeffries Wyman accompany the work. Professor Hayden has issued during the year No. I. of the second volume of his *Bulletin*. It is devoted almost wholly to archæology and anthropology. The articles are by Messrs. Holmes, Jackson, Bessels, and Barber, and contain profuse illustrations of the cliff-dwellings and the old Pueblo pottery. The Professor has also had plaster models made of the best preserved cliff structures.

Dr. Palmer has sent to the Smithsonian Institution an account of a mound excavated near St. Georges, Utah, which gives evidence of having been built up by reconstructing dwellings over the sites of those which had been burned, possibly on account of desertion at the death of the former occupant.

Principal J. W. Dawson read before the Victoria Institute, London, March 20th, a paper entitled "Fossil Agriculture in America."

The Geographical Society of Lyons publishes a paper, by M. Émile Guimet, upon the "Origin of the Ancient Mexicans." The object of the pamphlet is to overthrow the theory that relics of Egyptian influence are traceable in Mexican remains.

The most notable publication of the year upon North American archæology is a profusely illustrated work by Dr. Charles Rau, based upon the specimens in the National Museum. It has been issued by the Smithsonian Institution among the "Contributions to Knowledge." The archæological exhibition at the Centennial, under the direction of the same gentleman, has been the means of doubling the material and value of the national collection.

Middle America.—In the Proceedings of the American Philosophical Society, 1875, is a long and elaborate article on the Indians of Costa Rica, which makes several allusions to the antiquities of that country. Mr. Hyde Clarke's paper, read before the London Anthropological Institute, July 25th, on the "Worship of Siva in Central America," opens a new field of thought with reference to American mythology.

A paper upon the "Antiquities of Porto Rico" was read before the American Association by O. T. Mason, based upon the generous gift of Mr. George Latimer to the Smithsonian Institution, mentioned in the last volume of the *Record.*

South America.—Das Ausland, for April 24th, commences a series of articles upon ancient Peru, and Macmillan & Co. have in press a volume, by Mr. E. G. Squier, upon the same subject. J. J. von Tschudi has published in Vienna, "Ollanta, an old Peruvian Drama in the Quichua Language." The sixth volume of a great work, by Antonio Raimondi, entitled "Demarcacion Politica del Peru," is devoted to ethnology and archæology.

Herr Fritz Müller writes to Mr. Charles Darwin, in a letter published in *Nature*, April 1st, concerning the "Sambaques," or "Casqueros," shell-heaps of the Brazilian coast. They exist in great numbers and of immense size. In some of them skulls were found of unusual thickness.

Europe.—The *Quarterly Review*, No. 288, has an article upon the "Rude Stone Age in the Orkney Islands." Mr. Pengelly read before the British Association the report upon Kent's Cavern during the last year. The excavations, successful in other respects, revealed no human remains. Mr. Thomas Belt contributes to the *Quarterly Journal of Science* for July a paper on the "Geological Age of the Deposits containing Flint Implements at Hoxne, in Sussex, and the Relations that Palæolithic Man bore to the Glacial Period." Mr. A. Whitley made a communication to the Victoria Institute, March 20th, upon the "Flint Knives from Brixham Cave." The author is of the opinion that the older palæolithic knives, etc., are not of human manufacture. The exploration of Cisbury Camp, near Northing, Sussex, is reported in the Proceedings of the Anthropological Institute, November 23, 1875, and Professor Rolleston adds an exhaustive account of the animal remains, including the skeleton of a woman. Before the same society, Canon Rawlinson read a paper, May 3d, upon the "Ethnology of the Cymbri." Further information upon extinct races in Britain may be found in the following references: Professor Rolleston, on the "People of the Long-Barrow Period," Anthropological Institute, January 22d; on the "Tumuli belonging to the Viking Age," British Scandinavian Society, January 18th; on the "Traces of Early Phœnician, Jewish, and Carthaginian Intercourse in the British Isles," by Mr. F. A. Allen, Victoria Institute, February 21st; Aneurio Vaard, upon "Bardism, or the Primitive System of Instruction, Knowledge, and Morals among the Britons," in the *International Review*, March and April; Professor Rolleston, on the "Prehistoric Pig in Britain," Linnæan Society, June 15th. The tendency of English geologists is to refer the palæolithic implements of Britain to a preglacial, or at least to an interglacial epoch. Mr. Hughes, however, objects to the theory. The subject is discussed in *Nature* for September 21st, October 5th, and November 23d.

At the session of the anthropological section of the French Association, August 23, 1875, M. Valdemar Schmidt discussed the funeral rites of Scandinavia and other parts of the world. The subject of Swedish archæology is made accessible by a work entitled "Bibliographie de l'Archéologie prehistorique de la Suède pendant le XIXe Siècle." Stockholm, 1875, 106 pp. 8vo.

The *Revue d'Anthropologie* for February contains the description of the celebrated tumulus of Eshoj, in Denmark, by Professor C. Engelhardt.

Upon Russian archæology and antiquities the following treatises may be consulted: "Étude sur les peuples primitifs de la Russie; Les Meriens," by Count Ouvaroff, in *Matériaux* for May; "The Northern and Northeastern Frontages of the Indo-Europeans in Early Times," Anthropological Institute, H. H. Howorth.

In France the greatest interest is manifested in archæological matters. The three journals noticed in the preceding volumes of the *Record* continue their able editorial staffs, and are really the highest authority upon the French side of disputed questions. We select a few titles from many quite as able and important: "Superposition du Solutréen au Moustérien, à Thorigné," *Matériaux*, No. 4; Études sur quelques monuments megalithiques de la vallée de l'Oise," by Am. de Caix de St. Aymour (ibid.); "Les Tombes lacustres d'Auvernier," Dr. V. Gross (ibid.); "Histoire des mammifères quaternaires ou actuels de nos pays," J. Gaudry, No. 5; "Note sur la découverte d'une station humain de l'époque de la pierre polie près de Belfort," Ch. Grad (ibid.) The "Horse of Solutré" is discussed by E. Trutat, in the Bulletin de la Société d'Histoire Naturelle de Toulouse, 1874–1875. M. Vacher read a paper at the French Association upon the "Ancient places of adoration and upon traces of pagan worship in Auvergne and in Lemousin." In No. 3 of *Comptes-Rendus* there is an article by M. Jaubert upon human remains in the grottoes of different parts of Provence. The Rev. W. C. Lukis, through Johnson & Co., London, publishes a guide to the chambered barrows of South Brittany. The object of this Manual is to enable tourists to make good use of their time in visiting the dolmens of Morbihan, etc.

Drs. Rehman and A. Ecker contribute to the *Archiv für Anthropologie* an article on the quaternary fauna of the valley of the Donau. There is a growing disposition among German archæologists to set aside the division of the prehistoric age into palæolithic, neolithic, bronze, and iron periods; and several discussions have been published, not only in *Archiv*, but also in *Das Ausland* and other German periodicals, looking toward the adoption of two periods only—the stone and the metallic.

The Longmans have published a translation of Merk's work on the excavation at Kesserloch, near Thayngen, Switzerland, which will place this valuable treatise within the reach of English readers. Some doubt is thrown upon these relics by P. Lindenschmidt (*Archiv*, IX., 173). The discovery of sharpened sticks in an interglacial coal-stratum of Switzerland, noticed in the last *Record*, is reviewed by Professor Steenstrup in *Archiv*, under the question whether we have here veritable traces of man, or only the work of beavers. The learned archæologist accompanies his discussion with numerous illustrations, and adduces several instances of sticks in the Danish peat which were thus sharpened. The question what the lacustrians did with their dead has been partly answered by the discovery of one of their tombs on Lake Neuchâtel, between Auvernier and Colombier. The slab graves very much resembled those found in the mounds of Tennessee.

In *Matériaux*, No. 12, 1875, is an article by E. Rivière upon the quaternary fauna of the caverns of Baoussé-Roussé, in Italy, called the grottoes of Mentone. Rev. A. H. Sayce reviews in *Academy*, Jan. 29th, Corssen's great work on the Etruscan language. He considers it a failure, " but of such a useful kind that, if Corssen has failed to show that Etruscan is an Italic diet, the question, so far, may be considered as settled, for where Corssen has not succeeded, no one else will." Signor Alessandro Castellani read an instructive paper before the American Association upon Etruscan and Greek art in jewelry, and its revival. Count Gozzadini published at Boulogne, 1875, a beautifully illustrated quarto, entitled "De quelque mors de cheval italiques et de l'épée de Ronzano en bronze." In the Comptes-Rendus de l'Académie des Sciences, etc., de Boulogne, 1875, Signor J. Capellini treats of the Pliocene man in Tuscany. The argument rests, however, upon gashes in the bones of Balænotus and other water animals. To this P. C. de Fondouce replies (*Matériaux*, No. 5) that these gashes are often made in conflicts between individuals of living species. The most important archæological discoveries in Italy are those which have been made in the excavations at Rome.

Mr. Percy Gardner read a paper before the Royal Society of Literature, April 19th, on "Greek River Worship." The subject of glass manufacture among the ancient Greeks is discussed by X. Landerer in *Gaea*, 1876, p. 511. The objects are found mainly in the graves of women, and consist principally of long-necked vases, some of which contain toilet waters. Schliemann, in his researches at Mycenæ, claims to have found the tomb of Agamemnon, containing immense treasures.

Africa.—In the *Revue d'Anthropologie*, No. 3, for this year, is a paper by M. Tissot upon the megalithic monuments and the blonde people of Northern Africa. The article is followed by a learned discussion by Dr. Paul Broca upon the connection between these monuments, the blonde element in the population, and the early migration of white races into Northern Africa. He opposes the old opinion that the blonde element in the Berber race is derivable from the Huns of Genseric.

The Rede lecture delivered in the Senate-house of the University of Cambridge, by Samuel Birch, was upon the "Monumental History of Egypt." The whole period of Egyptian history is discussed from the earliest monumental remains to the time of Decius, 250 A.D. The subject of prehistoric remains is also discussed in the address. *The Quarterly Journal of Science*, January, 1876, reviews the "Papyrus Ebers," the Hermetic Book of Medicine of the ancient Egyptians, published in Leipsic, in two volumes, by Engelmann. In a paper read before the Victoria Institute, March 6th, Mr. W. R. Cooper discusses the "Horus Myth." Mr. E. Naville, of Geneva, is engaged in collecting the material for an exhaustive edition of the *Rituel Funéraire*, or "The Book of the Dead."

Asia.—In order to have any idea of the immense amount of work done yearly upon the subject of Asiatic archæology, one must study the Transactions and other publications of the Royal Asiatic Society and its East Indian branches, of the Society of Biblical Archæology, of the Société Asiatique, and of the Morgenländische Gesellschaft. Only the most meagre reference can be given here.

The American Palestine Exploration Society seems to be dying out. The Rev. Selah Merrill, however, still holds his ground. The new excavations in the Mesopotamian valley, cut off by the death of Mr. George Smith, will be continued by Mr. Hormuzd Rassam, who has obtained from the Porte a concession of protection for two years. The magnificent discoveries of Di Cesnola, at Kourium, Cyprus, will grace the Metropolitan Museum of Art, New York, where his other Cyprian relics are deposited.

Matériaux, No. 4, 1876, contains an illustrated article upon the erection of megalithic monuments still practiced by some of the mountain tribes of India. The whole series of translations from the "Sacred Books" of the world will be edited by Professor Max Müller. The work will be divided into six sections, under competent specialists, viz., Brahmin, Buddhist, Zoroastrian, Confucian, Lao-tsean, and Mohammedan.

Polynesia.—*Nature* for October 26th contains a lengthy abstract of a paper by Dr. Haast, read at the Philosophic Institute of Canterbury, New Zealand, on "Recent Cavern Researches in New Zealand." Mr. Wm. Brabrook read a communication before the Anthropological Institute, from Mr. W. W. Wood, "On the Tombs in the Island of Rotumah, Fiji." The finding of wooden tablets, containing hieroglyphic writing, upon the Eastern Island is announced in the *Geographical Magazine* for May.

II. ETHNOGRAPHY.

North America.—The translation of Dr. Rink's "Tales and Traditions of the Esquimaux," by Dr. Brown, places the investigations of the learned Dane within the reach of English-speaking students. The researches of Abbé Pétitot among the Tchiglit Esquimaux and the Dènè-Dindjié (Tinneh) Indians have been published through the generosity of M. Pinart, as Vols. II. and III. of his "Bibliothèque de Linguistique."

At the American Association at Buffalo the following communications were made upon North American ethnography: "The Iroquois Gens, Phratry, and Tribe," by Hon. L. H. Morgan; "Hybridity and Absorption among the Races of the New World," by Dr. Daniel Wilson; "The Mythology of the North American Indians," by J. W. Powell.

Very instructive manuscripts upon the Indian tribes of the United States have been sent in with the Centennial collections, by J. G. Swan, Rev. M. Eels, Stephen Powers, Rev. Stephen Bowers, Major J. W. Powell, and others. These will appear, from time to time, among the publications of the Smithsonian Institution. In *Das Ausland* for May 29th, Ado Hunnius gives a full statistical report of the Indians of the United States, drawn from official sources.

Middle America.—Professor W. M. Gabb, in a communication already referred to, and published in the Transactions of the American Philosophical Society, June to December, 1875, gives an elaborate account of the Indian tribes and language of Costa Rica. There is scarcely a topic in Herbert Spencer's "Descriptive Sociology" that is not treated in this paper.

"The Anthropology of the Antilles" is the subject of a paper, by M. Cornilhac, in the first volume of the Proceedings of the Société des Americanistes.

South America.—The Smithsonian Institution is in receipt of a manuscript from Lieutenant Harrison describing the natives along the Ucayali River, in Peru.

Wm. Gifford Palgrave, the author of a charming book of travels in Arabia, publishes, through Macmillan & Co., an account of a journey to Dutch Guiana.

Professor Hartt has found time to gather into a small pamphlet, published at Rio Janeiro, a collection of Amazonian tortoise myths.

In the November (1875) Bulletin of the Société de Géographie, M. Maguins gives an account of a visit to Tierra del Fuego. The *Revue Scientifique* describes an expedition to Patagonia by Dr. Carl Berg.

Europe.—Mr. E. W. Brabrook read before the Anthropological Institute, February 22d, a memoir by the Rev. J. Earle upon the "Ethnography of Scotland." The chief feature of the communication was the comparison of the physiognomy and dialects of the Scotch with those of the Norwegians. The same subject was discussed by Hector McLean at the British Association, September 16th. Lady Verny contributes to the *Contemporary Review* for February an essay on "Old Welsh Legends and Poetry."

The communication, by Gustavus Lagneau, read before the Geographical Congress in Paris last year, is published in full in *Revue d'Anthropologie*, No. 4, 1875, with copious bibliographical references.

The Basques are the subject of the following treatises: A paper read before the French Association, 1876, by M. Tubino; an article in *Revue de Linguistique*, October, 1855, by the Rev. Wentworth Webster; a notice in *Bul. de la Soc. de Géog.*, April, by V. Derrécagaix.

No. 3 of *Revue d'Anthropologie* contains a very elaborate paper, by Dr. A. Sasse, upon eighteen skulls which the author procured from an ossuary in Righ, a village in the north of Holland.

In the July number of the *North American Review*, Mr. T. F. Crane treats of the Italian popular tales.

M. Mainof, Secretary of the Ethnological Section of the Russian Geographical Society, is preparing an exhaustive treatise on Russian ethnography. It will appear in parts, each containing the monograph of a section of the people.

The Society of Anthropology of Paris offers a prize to the author of the best memoir on "The Slavic Races," to be accompanied by maps of the countries inhabited by Slavonians. Further contributions to Slavic subjects are: A paper read before the Royal Society of Literature, by Rev. J. Long, upon "Russian Proverbs as illustrating Russian Life and Manners;" a communication upon the Slaves, to the French Association, by M. Hovelacque; an article in the April number of the *Contemporary Review*, by W. S. Ralston, on "Russian Idyls." The October number of the *Geographical Magazine* is devoted largely to the Turkish question. Maps are given, showing the political divisions, the density of population, the distribution of the Mohammedans, and the other nationalities. Dr. Nicolo J. Petrovitsch contributes to *Das Ausland*, June 19th, an article on "Manners and Customs in Servia;" E. Picot, to *Revue d'Anthropologie*, No. 3, 1875, a paper on the Roumanians; and Jos. Jirecek publishes, in Prague, "The History of the Bulgarians."

Africa.—In speaking of the megalithic monuments of Africa, reference was made to the blonde population of Morocco (*Revue d'Anthropologie*, No. 3, 1876). The novel opinions of M. Broca are well worth careful investigation.

Further information of African subjects is to be found in Mr. B.

Walker's paper before the Anthropological Institute on the "Religion, Politics, and Commerce of the Old Calabar Coast;" in M. Hovelacque's article in *Revue d'Anthropologie*, No. 2, on the "Caffres;" in Dr. B. Ferrand's contribution to the third part of the same journal on the "Oulofs of Senegambia;" in Captain Cameron's speeches before the Geographical Society, April 11th, the Anthropological Institute, May 23d, and at the British Association; in Dr. Hartmann's work on the "Nigritians," published in Berlin; in Dr. Mullen's paper in the *Jour. Anth. Inst.*, V., 181, on the "Origin and Progress of the People of Madagascar;" and in No. 4 of Herbert Spencer's "Descriptive Sociology."

Asia.—M. Ujfalvy has been intrusted by the French Minister of Instruction with the preparation of a work on the ethnographical, linguistic, and historical characteristics of the people of Russia and Central Asia. *L'Explorateur*, of May 18th, contains an account of the principal indigenous tribes of Eastern Siberia, from "La Sibérie Orientale, et l'Amérique Russe," of M. Octave Sachat. At a meeting of the Ethnological Section of the Russian Geographical Society, May 13th, M. Venioukoff's recommendation to publish a catalogue of all books and articles relating to Higher Asia and its inhabitants was adopted.

Messrs. Sampson & Low publish a translation of Lieutenant Prejevalsky's "Mongolia," with an introduction by Colonel Henry Yule. The lieutenant will conduct to Central Asia a party, to be gone three years. Ethnological investigations will be a prominent feature of their work.

In the *British Quarterly*, Jan., 1876, is an article on the "Dervishes of Islam," attempting to compare them with the prophets of the Old Testament.

Mr. Alfred Morgan read a paper before the Philosophical and Literary Society of Liverpool, January 10th, on the Khasi Hill Tribes of Northeastern Bengal. In the *Jour. Anth. Inst.* for April, Mr. J. Walhouse describes the Bhutas—devil and ghost worshipers in India. Professor Childers, in *Contemp. Review* for April, has an article entitled "The Whole Duty of the Buddhist Layman."

Maisonneuve & Co., Paris, have published for C. A. Piétrement a pamphlet upon the origin of the Chinese, and the introduction of the horse into China. The *Argonaut*, for July 1st, has an article on the "Amusements of the Chinese."

In the *Jour. Anth. Inst.* for July, Mr. E. B. Tylor discusses the myths of the Japanese.

Oceanica.—The attention of European anthropologists is turned especially to New Guinea. Articles on this subject may be found under the following references: *Archiv für Anth.*, May; *Edinburgh*

Review, July; *Proceedings of the Geographical Society*, June, p. 253, 266; *Jour. Anth. Inst.*, April 25th and June 13th; *Nature*, Dec. 25th, 1875, Jan. 20th, March 9th, June 1st and 8th, 1876; *Academy*, Feb. 19th.

In the *Jour. Anth. Inst.* for April, Mr. James Hector speaks of "Certain Early Forms of Stone Implements in New Zealand." The Rev. Wyatt Gill has, during the year, presented to the Anthropological Institute papers on "The Traditions of the Hervey Islanders," "The Origin of the South Sea Islanders," and "The South Sea Island Mythology." The last-named article is reviewed at length in the *London Quarterly Review* for July. The Rev. S. J. Whitmee, in *Nature*, June 29th, makes some sound observations on the errors which have been made in estimating the population of a country by the census of the sea-coast. Mr. Rankin contributes to the *Jour. Anth. Inst.* for July information upon the South Sea Islanders. Professor Busk has examined skulls from the Hebrides, some of which show signs of artificial compression (*Anth. Inst.*, June 13th). Peschel's "Völkerkunde" has appeared in an English translation, published by D. Appleton & Co., and supplies a felt want of a compendious work on the whole field of anthropology.

III. DEDUCTIVE ANTHROPOLOGY.

1. *Origin and Antiquity of Man.*—The *Quarterly Journal of Science* for October contains an article upon the "Cradle of Civilization." "The Origin and Development of Man," is the title of a critique on Lubbock, Tylor, Lyell, and Huxley, in the *Westminster Review* for January. Mr. A. R. Wallace, in opening the Anthropological Section of the British Association, was pleased to speak in the highest terms of the theory of Mr. Darwin in its application to man, but also to enumerate some of the difficulties which still stand in the way of its total recognition. On the other hand, Dr. Ernst Haeckel takes the broad ground that, from beginning to end, all animated creation is the fruit of "transmission and adaptation." Professor Flower took the occasion of his Hunterian lecture on the "Relation of Extinct to Existing Mammalia" to speak of the geological origin of man. Mr. Frank Clarkson spoke on the "Antiquity of Man" before the Junior Philosophical Society, June 19th. In *Mém. de la Soc. d'Émulation des Côtes-du-Nord*, M. Victor Micault discusses the various time-measures furnished by geology for ascertaining the antiquity of man.

2. *Anatomical and Physiological Investigations.*—The study of cranio-cerebral topography promises to place phrenological researches on a new basis. The subject as treated by Gratiolet, Bischoff, Hunter, Ecker, Heftler, Féré, and others is fully reviewed, with illustrations, by Dr. Paul Broca, in *Revue d'Anthropologie*, No. 2, 1876. The author also gives his own views *in extenso*. The value of the "Orbital Index" is treated in the same journal, No. 4, 1876. Dr. Ecker, in discussing the fluctuating character of the human hand

(*Archiv*, VIII.), calls attention to the length of the fore- and the ring-finger. Dr. Kuhf, in *Revue d'Anthropologie*, No. 3, reviews J. W. Sprengel's "Schädel vom Neanderthal-Typus," and contributes also some notes on prehistoric femurs. Dr. R. Verneau, Paris, is the author of a pamphlet entitled "Le Bassin dans les Sexes et dans les Races" (*Rev. d'Anth.*, No. 2, 1876). Dr. Schmidt, of Essen, contributes to the first quarter of *Archiv* a very elaborate paper upon the true horizontal of the skull. In the same number Dr. A. Ecker discusses the influence of cranial deformation upon the volume, position, and form of the cerebrum and its single parts. Dr. Daniel Wilson read a paper before the American Association on "Brain Weight and Size in Relation to the Relative Capacity of Races." The subject of the anthropology of idiots is discussed in *Archiv für Anth.*, IV., 317. A paper on "Right-handedness" was read before the British Association by Mr. James Shaw. Professor Virchow, in *Abhandl. der Königl. Akad. zu Berlin*, considers some characteristics of the skulls of the lower races of mankind.

3. *External Characters.*—The *Jour. Anth. Institute* reproduces, with plates, the article of Dr. Pruner Bey (*Anth. Rev.*, II., 1864) on "Human Hair as a Race Character." The treatise will well repay a second reading to those who have not had the benefit of the plates.

4. *Comparative Psychology.*—The *Quarterly Journal of Science* publishes an article, by G. J. Romanes, on "Conscience in Animals." The subject of mental progress of animals during the human period was discussed by Mr. James Shaw before the British Association. Articles entitled "Associationism and the Origin of Moral Ideas," and "Evolution in Ethics," are published in *Mind* for July 1, 1876. Professor Barret read before the British Association a paper on "Some Phenomena associated with Abnormal Conditions of the Mind." A warm discussion ensued, in which there was a lack of "philosophic calmness." Professor Paul Mantegazza contributes to *Archivio* a long and studied essay on the "Expression of Grief."

5. *Sex and Race.*—In *Ausland*, for June 19th, Dr. Escherich discusses the numerical relations of the sexes in Prussia, Bavaria, and Würtemberg. In all cases—and the reasons are assigned—there is a preponderance of women over men. Before the London Institution, March 23d, Mr. E. B. Tylor read a communication on the "Races of Mankind and their Civilization."

6. *Environment.*—The influence of geological phenomena upon human migrations was discussed by M. Roujou in a communication to the French Association. Ferd. F. von Andrau treats of the influence of elevation upon human settlements in the *Mittheil. der Anth. Gesellsch.*, in Wien, 1 and 2. M. Paul Bert's treatise on the "Pressure of the Air and Living Beings" is reviewed in *Rev. Sc.*, July 15th, and in *Rev. d'Anth.*, No. 2. In the last-named journal, No. 3, M. A. Morice discusses the "Acclimation of Races of Men and Animals in Lower

Cochin China." *Ausland*, May 29th, reviews Rutimeyer's "Variations of the Animal Kingdom in Switzerland since the Presence of Man there." The Smithsonian Report for 1875 reproduces De Candolle's "Probable Future of the Human Race," from "History of Science and Savans."

IV. CULTURE.

1. *Comprehensive Treatises.*—The *Westminster Review* for July criticises the works of Lubbock and Southall on the early phases of civilization.

2. *Food.*—On this subject we notice Dr. M. J. Schleiden on the "History, Uses, and Symbolism of Salt."

3. *Dwellings and other Constructions.*—Vicomte F. de Langle contributes to the *Bull. Soc. de Géog.*, June, 1876, an essay on "Monuments Megalithiques."

4. *Vessels and Household Utensils.*—In *Ausland*, June 10th, will be found an interesting paper on the early use of pot-stone (*Lapis ollaris*).

5. *Implements of War, the Chase, and Industry.*—Mr. Alfred W. Howitt, writing from Baimsdale, Victoria, to *Nature*, July 20th, minutely describes his experience with the boomerang. Professor George Fischer, of Stuttgart, has published a work on "Nephrite and Jadeite in their Mineralogical Character, and in their Prehistoric and Ethnographical Relation" (*Corr.-Blatt.*, No. 12, 1875). In Nos. 10 and 11 of *Matériaux* for 1875, M. Mortillet contends for the East Indian origin of bronze. Madame Clemence contributes to *Revue d'Anth.* one of her characteristic papers on "Fire among Primitive Peoples." Dr. Büchner writes in *Gaea* (III., 1876) upon the kindred subject, "Die Aeltesten Feuerzeuge."

6. *Domestication.*—Upon the history of the horse attention is called to M. C. A. Pietrement's publications in Paris. M. Hovelacque has published at Paris also a treatise on the "Dog in the Avesta."

7. *Valuing and Measuring.*—A communication to the London Philosophical Society, March 22d, treated of "Coinage in Ancient and Modern Times."

8. *Music.*—Professor Carl Engel's descriptive catalogue of the musical instruments in the South Kensington Museum is prefaced by an essay upon the history of musical apparatus.

9. *Art.*—Upon this subject the following treatises have come before us: "Artes Africanæ," by Dr. George Schweinfurth; "The Artistic Skill of the Africans," *Ausland*, Nov. and Dec., 1875; "Analysis of the Life Form in Art," *Trans. Am. Phil. Soc.*, 1875; "Vorgeschichte der Kunst," Dr. O. Hostinsky, *Ausland*, June 24th, 1876; "L'Art et ses Progrès depuis l'Antiquité," Émile Soldi, Paris, 1876; "A Manual of the Historical Development of Art," G. G. Zerffi, London.

10. *Language.*—The two volumes of Abbé Pétitot, previously re-

ferred to, must be recalled here. M. Couderеau is the author of a very elaborate paper in *Bull. Soc. d'Anth.*, No. 3, 1875, entitled "Essai de Classification des Bruits Articules." Attention is called to Rev. A. H. Sayce's review of Hovelacque, *Nature*, Aug. 10th; "Language and Race," *Jour. Anth. Inst.*, V., II., 212; "The Jelly-fish Theory of Language," *Contemp. Rev.*, April, 1876; and "The Introduction to the Science of Language." Mr. Hyde Clarke contributes to the *Jour. Anth. Inst.* interesting papers on prehistoric language (*Nature*, May 25th; *Athenæum*, Aug. 5th); The Fifth Annual Address of the Rev. Richard Morris before the London Philological Society, May 19th, is an admirable summary in this special field. The author had the aid of Dr. J. Muir and Professor Eggeling on Sanskrit; of Ujfalvy on the Ugro-Finnish; of Dr. Neubauer on Talmudical and Rabbinical Literature; of the Rev. A. H. Sayce on the Etruscan; of R. N. Cust on the Non-Aryan Languages of India; of Dr. J. H. Trumbull on N. A. Indian Languages; of Edouard Naville on the Egyptian; and of Dr. Kölbing on Teutonic Languages.

11. *The Family.*—"La Famiglia e la Societa negli Animali e nell' uomo" is the name of an article in *Rivista Anth. ed Eth.*

12. *Social Life and Customs.*—The following treatises are to be noticed: "La Trépanation Préhistorique," J. de Baye, Paris; "Cremation," *Dublin Review*, No. 157; "Les Rites Funéraires," etc., M. Royer, *Rev. d'Anth.*, No. 3; "The Last Act," Wm. Tegg, London; "Sur l'usage des Bâtons de Main," F. Chabas, 1876; "Wege und Ziele der Oekonomie," Dr. Weiss, *Ausland*, June 5th, 1876.

13. *Religion.*—Our space allows us merely to call attention to the following: M. Mortillet's address before the French Association on the "Origin of Superstitions;" Tiele's "Law of Religious Development," *Rev. Politique*, Aug. 12th; "The Chief Non-Christian Systems of Religion," by the Society for Promoting Christian Knowledge; Miss Buckland's paper on "Rhabdomancy and Belomancy," *Jour. Anth. Inst.*, April; Dr. Wakes Smart on "The Ancient Worship of Strings," Brit. Arch. Assoc.; Dr. Collineau on "Religious Mania," *Bull. Soc. d'Anth.*, No. 3, 1875; "Lucky Days," etc., *Mittheil. Anth. Ges. in Wien;* "Serpent and Siva Worship in America," Hyde Clarke, *Anth. Inst.*, June 27th; "Demonolatry," etc., *Contemp. Review*, Feb.; W. P. Distant on the "Term Religion in Anthropology."

V. INSTRUMENTALITIES OF RESEARCH.

Apparatus of Observation.—"Instructions Craniologiques et Craniométriques," *Soc. d'Anth.*, Paris; "La Cranioscope," M. Lenhossek, *Mém. Acad. Soc.*, Buda-Pesth; "Zur Frage nach der Methode der Schädelmessung," *Corr.-Blatt.*, I., 1876.

Terminology.—Ecker, in *Archiv*, May, on "Prehistoric Terminology;" a paper by O. T. Mason, American Association, on the "Scope of Anthropology and the Classification of its Materials." Discussions on the terms "Anthropology," "Ethnology," and "Ethnography" in *Bull. Soc. d'Anth.*, Nos. 2 and 3.

Societies and Transactions.—The *Annual Record* for 1875 contains a full account of these. The American Anthropological Society founded at Philadelphia, Sept. 9th, is the only addition made to the list of societies, and *Beiträge zur Anthropologie und Urgeschichte Bayerns* to the list of journals. The next Congress of Americanists will meet at Luxemburg, Sept. 10th–13th, 1877. The annual meeting of the Indiana State Archæological Association convened at Indianapolis, Oct. 17th. The third session of the International Congress of Orientalists was opened at St. Petersburg, Sept. 9th. The British Association meet in Glasgow, Sept. 6th; the French Association at Clermont-Ferrand, Aug. 18th–25th; the Eighth Congress of Anthropology, etc., met at Buda-Pesth, Sept. 4th. The annual meeting of the German Anthropological Society was held in Jena, Aug. 9th–11th. The American Association was held in Buffalo, Aug. 23d–30th, Hon. Lewis H. Morgan being chairman of the Anthropological Subsection. The next meeting will be held in Nashville, Tenn., and Dr. Daniel Wilson will preside over the Anthropological Subsection.

In conclusion, we refer our readers to Gerland's "Atlas der Ethnographie," Leipzig, Brockhaus, 1876; "Le Dictionnaire Archéologique de la Gaule," A–G, Paris; "Verzeichniss der Anthropologie schen Literatur," H. Schaaffhausen und A. Ecker, Berlin; "Nouvelle Géographie Universelle, la Terre et les Hommes," E. Reclus, liv. 1–66; "Bibliographie de l'Archéologie Préhistorique de la Suède pendant le XIX^{e} Siècle," Montelius, Stockholm, 1875; "Crania Ethnica," Quatrefages & Hamy, liv. 1–4, Paris, 1875; "Thesaurus Craniorum," J. Barnard Davis, London.

GENERAL ZOOLOGY.

I.—By Dr. A. S. PACKARD, Jr.

A review of the work accomplished by zoologists during the year 1876 shows no diminution in the interest felt in this subject, either abroad or at home.

The British Arctic Expedition has returned with zoological collections of great value, while the arctic expeditions of the Swedish government, under Nordenskjöld, and the Norwegian deep-sea expedition to Iceland, as well as the researches in the Rocky Mountains carried on in connection with Professor Hayden's United States Geological and Geographical Survey of the Territories, have been productive of good results.

A very thorough survey of the Baltic is in progress, under the direction of the German minister of agriculture. We have received the zoological portions of the reports, which are of much interest. They are in the same direction as the reports of our United States Fish Commissioner, which are confined by government, as yet, chiefly to fisheries and fish-food.

A summer school of Biology, under the auspices of the Peabody Academy of Science, was held at Salem, Massachusetts, with such success that it is hoped that this institution, with its advantages for the study of marine life, may lead to the establishment at this point of a zoological station for naturalists as well as science-teachers. In Germany they are agitating the establishment of a new zoological station at Kiel and Heligoland, while others have been started at Trieste and Sebastopol, and there is a plan to erect a Russian station on the White Sea. The small station at Roscoff, on the coast of Normandy, France, established by Professor Lacaze-Duthiers, is still useful; while Dr. Anton Dohrn's magnificent establishment at Naples, the parent of all these enterprises, has afforded special facilities to some of the leading observers of Europe; and, while it has been a costly undertaking, Dr. Dohrn writes that "there is well-founded hope that the Naples station will soon be free from such embarrassments as are the consequences of insufficient means," since the German government will probably grant five or six thousand dollars to its maintenance.

Articles on progress in American zoology during the past century have been published in *Harper's Magazine*, by Professor T. Gill, and in the *American Naturalist*, by the writer.

Professor E. S. Morse's discourse, as President of Section B, Geology and Biology, of the American Association for the Advancement of

Science, was on the contributions made to the theory of Evolution by American naturalists.

In his late address before the section of Biology of the British Association, Mr. Alfred R. Wallace remarked on the peculiar relations of plants and insects as exhibited on islands. As many plants can only be fertilized by insects, the absence of the latter would, of course, tend to prevent the continued existence of plants. This affords a clew to much of the peculiarity of the floras of oceanic islands. Albatrosses, gulls, puffins, tropic birds, and many others nest inland, often amid dense vegetation; and it is thought that they often carry seeds, attached to their feathers, from island to island, for great distances. In the tropics they often nest on the mountains, far inland, and may thus aid in the distribution even of mountain plants. Insects, on the other hand, are mostly conveyed by currents of air, especially by violent gales; and it may thus often happen that totally unrelated plants and insects may be brought together, in which case the former must often perish for want of suitable insects to fertilize them. Much of the poverty and exceptional distribution of the plants of the Polynesian Islands is probably due to the great scarcity of flower-frequenting insects. Lepidoptera and Hymenoptera are exceedingly scarce in the eastern islands of the Pacific, and it is almost certain that many plants which require these insects for their fertilization have been thereby prevented from establishing themselves. In the western islands, such as the Fijis, several species of butterflies occur in tolerable abundance, and no doubt some flower-haunting Hymenoptera accompany them; and in these islands the flora appears to be much more varied, and especially to be characterized by a much greater variety of showy flowers. Mr. Moseley has suggested that a flower which had acquired a brilliant color to attract insects might, on transference to another country, and becoming so modified as to be capable of self-fertilization, retain the colored petals for an indefinite period. Such is probably the explanation of the pelargonium of Kerguelen's Land, which forms masses of bright color near the shore during the flowering season, while most of the other plants of the island have colorless flowers, in accordance with the almost total absence of winged insects. "The researches of Dr. Herman Müller have shown us by what minute modification of structure or of function many flowers are adapted for partial insect- and self-fertilization in varying degrees; so that we have no difficulty in understanding how, as the insects diminished and finally disappeared, self-fertilization may have become the rule, while the large and showy corollas remain to tell us plainly of a once different state of things."

A new work, by Mr. Alfred R. Wallace, on the geographical distribution of animals, bids fair to prove of much interest to naturalists, though it will afford food for discussion.

The essays by Mr. J. A. Allen on the geographical distribution of certain birds and mammals, notably the bison, and the essay by the writer, on the distribution of the Geometrid moths, in his monograph of that family, are fresh contributions to zoögeography.

In a paper on the origin of the deep-water fauna of the Lake of Geneva, M. Forel thinks the entire fauna of the Swiss lakes is descended from forms which have migrated up the rivers since the melting of the glaciers, and have afterward been differentiated.

Among recent contributions to the general subject of the embryology of animals are two by Professor E. Van Beneden, of Liege. One is on the maturation and fecundation of the egg and earlier embryonic phases of the mammals, from researches made on the rabbit, and is an extension of Bischoff's famous work on the embryology of the rabbit. A second paper, on the history of the germinative vesicle, is based on studies made on the common star-fish of the European coast (*Asteracanthion rubens*). A paper of a very different sort is a fierce attack on the " gastræa " theory, by M. Moquin-Tandon, in the *Annales des Sciences Naturelles*. He concludes that it does not rest on any fundamental fact, and can not serve as a base of a phylogenetic classification. The theory had previously been attacked in the *American Naturalist* for February by Mr. A. Agassiz. On the other hand, in the April number of the same magazine, Professor Cope, in an article entitled "Progress of Discovery of the Laws of Evolution," welcomes Haeckel's gastræa theory, which we have previously explained. Cope says that this theory has "added the keystone to the doctrine of evolution in his gastræa theory."

Several embryological papers of value have been published by Balfour, who also fully indorses the gastræa theory of Haeckel.

Some four years ago the Rev. W. H. Dalliger and Dr. Drysdale began to publish a series of papers, which have attracted much notice, on the life-history of monads. The last is now published. The authors remark that simple conditions of season and temperature may account for their successive appearance in the fluid, without supposing that one form was developed out of another. "On the contrary, the life-cycle of a monad is as rigidly circumscribed within defined limits as that of a mollusk or a bird." In no instance was the continuance of the species maintained without the introduction of a sexual process, a blending of what were shown in the sequel to be genetic elements. The experiments as to the effect of heat on the monads and their spores uniformly established an important fact, viz., that the spores resist heat much better than the adults. A temperature of 150° Fahr. was always found to destroy utterly all the adult forms, while the spores resulting from sexual generation have a power of resistance to heat which is greater than this in the proportion of eleven to six on the average. "This appears to us," they say, "to be the very essence of the question of biogenesis *versus* abiogenesis. In some, at least, of the septic organisms spores are demonstrably produced, and these spores can resist a temperature nearly double that of adults on the average; that which some can resist is 88° Fahr. above the boiling-point of water." This, adds the *Quarterly Journal of Microscopical Science*, is in harmony with the experiments of Roberts, and the later ones of Huizinga.

In a little book entitled "Half-Hours with Insects," the writer cites a number of unpublished facts regarding mimicry in insects, and inclines to the belief that the resemblance in pattern and color between insects belonging to different groups is probably due to causes more fundamental than natural and sexual selection, and reaching possibly farther back in geological time than the present period. The majority of mimickers of other insects belong to groups lower in the organic scale than the insects they mimic, and may have been preserved by virtue of their resemblance to butterflies originating at a later date.

In his address at the last meeting of the British Association for the Advancement of Science, Professor Alfred Newton adverts to the subject of the extinction of animals by natural and artificial or human causes. "It is notorious," he says, "that various members of the orders *Sirenia*, *Cetacea*, and *Pinnipedia* have recently dwindled in numbers, or altogether vanished from the earth. The manatee and dugong have been recklessly killed off from hundreds of localities where but a century or so since they abounded, and with them the stores of valuable oil that they furnished have been lost. That very remarkable Sirenian, the huge *Rhytina gigas*, has become utterly extinct. The greed of whalers is believed to have had the same effect on a cetacean (the *Balæna biscayensis*) which was once the cause of a flourishing industry on the coasts of France and Spain. The same greed has almost exterminated the right-whale of the northern seas, and is fast accomplishing the same end in the case of seals all over the world." He also speaks of the alarming decrease of fish and edible mollusks.

Perhaps the most remarkable biological work of the year is Professor August Weismann's treatise on the "Final Causes of Transmutation," forming the second part of his studies on the "Theory of Descent." The first part of the work, entitled "Seasonal Dimorphism," was noticed on p. cxciv. of the *Annual Record* for 1875. The present work is divided into three divisions, of which the first presents an array of facts on the origin of the markings of caterpillars. The author describes the nature and morphology of the markings of larvæ of the family *Sphingidæ*, their biological value, and phyletic development, concluding that the oldest sphingid caterpillars were without markings, that the oldest style of markings were longitudinal lines, the later ones oblique streaks, and the last to be developed were the spots. This part of the subject is illustrated by five colored plates. In the third section the transformation of the Mexican axolotl into an *Amblystoma* is discussed at considerable length and with characteristic thoroughness. Professor Weismann believes that the *Siredon* or axolotl was originally derived from a land salamander (*Amblystoma*), but has reverted to an axolotl or larval form through the change of the climate of Mexico from a damp to an exceedingly dry one, obliging these animals, which as larvæ lived in ponds, and as adults formerly lived under trees and stones or in damp places, to revert to the original larval siredon form and remain permanently amphibious. In the fourth division, "On the Mechanical Conception of Nature," the author maintains that development is mechanical, and that we must reject the idea of a special life-force. Still he as strongly believes in teleology, and maintains the thesis that evolutional views do not lead to materialism.

II.—By Dr. THEODORE GILL.

One of the most important works of the year is a treatise, in two volumes, "On the Geographical Distribution of Animals, with a Study of the Relations of Living and Extinct Faunas, as elucidating the past Changes of the Earth's Surface," by Alfred Russell Wallace, author of the "Malay Archipelago," and a co-discoverer with Darwin of the law of Natural Selection. This author has long been favorably known as a geographical zoologist, and first defined the boundaries between the Australian and Indian realms.

He divides his subject into several parts. In the first part he discusses the principles and general phenomena of the distribution under chapters, (1) introductory; (2) the means of dispersal and the migrations of animals; (3) distribution as affected by the conditions and changes of the earth's surface; (4) on zoological regions; and (5) classification as affecting the study of geographical distribution. In the second part he discourses on the distribution of extinct animals; and in the third part he enters into a consideration of "zoological geography: a review of the chief forms of life in the several regions and sub-regions, with the indications they afford of geographical mutations." In a fourth and final part he considers the geographical zoology in a systematic sketch under the different families of animals in their geographical relations.

The older naturalists, says Mr. Wallace, "had a sort of vague notion that certain forms were peculiar to hot climates, and that certain others were only found in cold countries; but that was about all they knew or cared to know. Of the necessity of precise knowledge on the subject of locality they were absolutely incredulous. To the modern naturalist, on the other hand, the native country, or 'habitat,' as it is technically termed, of an animal or a group of animals is a matter of the first importance, and, as regards the general history of life upon the globe, may be considered to be one of its essential characters. The structure, affinities, and habits of a species now form only part of its natural history. We require, also, to know its exact range at the present day and in prehistoric times, and to have some knowledge of its geological age, the place of its earliest appearance on the globe, and of the various extinct forms most nearly allied to it. To those who accept the theory of development as worked out by Mr. Darwin, and the views as to the general permanence and immense antiquity of the great continents and oceans so ably developed by Sir Charles Lyell, it ceases to be a matter of surprise that the tropics of Africa, Asia, and America should differ in their productions; but rather that they should have any thing in common. Their similarity, not their diversity, is the fact that most frequently puzzles us."

The author has confined his investigations to the several classes of vertebrates, a few prominent families of insects, and the branch of mollusks. An analysis of his work, however, reveals that he was chiefly influenced by the phenomena of the distribution of birds, with which class he was evidently most familiar; with the other classes he was apparently but imperfectly conversant. In one paragraph (vol. i., p. 56) he discusses the question of "which class of animals is of most importance in determining zoological regions." He arrives at the conclusion that in all essential points "the mammalia are pre-eminent; and they possess the additional advantage of being the most highly developed class of organized beings, and that to which we ourselves belong." Many naturalists, however, will be disposed to dissent from him in this view; and, taking the author's own standard of what best qualifies a group for the expression of laws of geographical distribution, we are constrained to believe that the inhabitants of fresh-water basins, and especially the fishes, are pre-eminently the most truth-telling exponents of the relations of the several regions of the globe to each other now and in the past. It is evident, however, that, in spite of the expression of opinion of the author, he has been influenced by the facts of geographical distribution of mammals much less than by those of birds; and to this bias is undoubtedly attributable the sequence and combinations of the "regions" which he has adopted. These regions are six in number, and for them he adopts the names of his compatriot, Mr. Sclater. The regions are divided by a procrustean system each into exactly four sub-regions. They are as follows:

I. The Palæarctic Region, with the sub-regions (1) North America, (2) Mediterranean (or S. Eu.), (3) Siberia, and (4) Manchuria (or Japan).

II. The Ethiopian Region, with the sub-regions (1) East Africa, (2) West Africa, (3) South Africa, and (4) Madagascar.

III. The Oriental Region, comprising the sub-regions of (1) Hindostan (or Central Ind.), (2) Ceylon, (3) Indo-China (or Himalayas), and (4) Indo-Malaya.

IV. The Australian Region, embracing the sub-regions of (1) Austro-Malaya, (2) Australia, (3) Polynesia, and (4) New Zealand.

V. The Neotropical Region, including the sub-regions of (1) Chili (or S. Temp. Am.), (2) Brazil, (3) Mexico (or Trop. N. Am.), and (4) Antilles.

VI. The Nearctic Region, with the sub-regions (1) California, (2) Rocky Mountains, (3) Alleghanies (or Eastern U. S.), and (4) Canada.

This is not the place to further comment upon Mr. Wallace's views. Suffice it to say that, although there are many errors, the work is one of sterling value; and will doubtless give a decided impetus to the philosophical consideration of the phenomena of the distribution of animal life over the earth, and its causes.

INVERTEBRATE ZOOLOGY.

BY DR. A. S. PACKARD, JR.

The Rhizopods of this country are still undergoing examination by Professor Leidy. In speaking of the Difflugian Rhizopods, Dr. Wallich expresses the opinion that the whole are referable to a single specific type, while Dr. Carpenter is quoted as saying that "whether it will ever be practicable to arrange the multitudinous forms of this group in natural assemblages, whose boundaries shall be capable of strict limitation, is to us by no means certain." Dr. Leidy adds that it would seem that the existing rhizopods, in respect to classification, may be viewed as an epitome of all organic forms in all times; for, if all these could be known, it would be found that there were no absolute limits defining species, or any other of the usual divisions in classification. Many of the fresh-water forms of this country are identical with those of Europe. The *Amœba*, it will be remembered, is the simplest form of rhizopod, while the shelled forms are called Foraminifera, and Eozoon is supposed to be one of these.

An account by Hertwig of a new acinetan infusorian (*Podophrya gemmipara*) appears in the new German *Journal of Anatomy and Embryology*, edited by Gegenbaur. After a review of the structure of the Acinetæ generally, the author speculates on the origin of these interesting forms, and believes that the original ancestral form from which the Acinetæ and infusoria sprang was a one-celled organism covered with cilia.

Dr. Bütschli describes the production in *Podophrya* of ciliated young, somewhat resembling those of other normal *Infusoria ciliata*.

The sun-animalcule (*Actinophrys Sol*) has been observed by Mr. Fullagar to pass through the following changes. After encysting, having previously drawn in its spine-like "pseudopodia," it divides into two equal-sized globes, which, after remaining separate for a few hours, unite again, forming a smaller sphere than the original one. It now moves about by thrusting out two or three pseudopodia, and then resting for a while. At times also a cloudy matter exudes from them, out of which Amœba-like bodies proceed, resembling the forms of different so-called species of Amœba. The author asks, "What connection have they with *Actinophrys Sol*, being found so closely mixed up with them?" He does not answer the question; but, judging from the mode of development of certain moners described by Haeckel, the minute Amœbæ may prove to be young Actinophrys. Should these observations be confirmed, Mr. Fullagar has, perhaps, discovered the mode of reproduction by encysting and the formation of motile Amœba-like young, which has not yet been observed in this animalcule. He also describes the formation of young Actinophrys by self-division. Two modes of reproduction, then, seem to be established—one by encysting and the other by self-division. Graef had noticed previously the multiplication of the sun-animalcule by self-division, and Schneider had also seen them encyst themselves in the autumn, and the small Actinophrys come out of the cyst in the spring.

In special groups of animals, beginning with the lowest, we have fresh information regarding the foraminifera, or lower shelled rhizopods. One of these animals, the *Globigerina*, has at length been seen by the *Challenger* party with its "pseudopodia," or thread-like extensions of the body, spreading out in the water. Professor Wyville Thompson states that if a specimen be immediately transferred from the tow-net to some fresh sea-water, and be examined with a high power, the "sarcodic contents of the chambers may be seen to exude gradually through the pores of the shell, and spread out until they form a gelatinous fringe or border around the shell, filling up the spaces among the roots of the spines, and rising up a little way along their length." It will be remembered that the dead shells of these foraminifers accumulate in such immense quantities as to form modern chalk at great ocean depths.

The sponges are now recognized as a distinct sub-kingdom of animals by Huxley, Macallister, and Hyatt. Their embryology has been restudied with great thoroughness by Barrois, a French observer, who, with F. E. Schulze, acknowledges the presence of three germ-layers, and confirms the embryological observations of Haeckel.

Professor Hyatt's "Revision of the North American Poriferæ" is the first installment of a series of papers on our native sponges, comprising considerable work done under the auspices of the United States Fish Commission, as well as on specimens from the different museums of the country. It is accompanied by a plate drawn on stone, and contains remarks on foreign species.

While the sponges are thus taken from the Protozoa on the one hand, and the Polyps on the other, and regarded as representatives of a distinct sub-kingdom, Professor E. Van Beneden, in his elaborate "Recherches sur les Dicyemides, survivants actuels d'un Embranchement des Mesozoaires," proposes a new sub-kingdom of animals. In 1830 Krohn observed the presence in the liquid bathing the spongy bodies (perhaps renal organs) of different species of cephalopods certain filiform bodies, covered with vibratile cilia, and resembling infusoria or ciliated worms. They were called *Dicyema* by Kölliker, who, with others, considered them as intestinal worms.

Van Beneden claims that they have no general body-cavity. The body is formed (1) of a large axial, cylindrical, or fusiform cell, which extends from the anterior extremity of the body, enlarged into a head, to the caudal extremity; (2) of a single row of flat cells, forming around the axial cell a sort of simple pavement epithelium. All these cells are placed in juxtaposition like the constituent elements of a vegetable tissue. There is no trace of a homogeneous layer, of connective tissue, of muscular fibre, of nervous elements, nor of intercellular substance. There is only between the cells a homogeneous (*unissante*) substance, as between epithelial cells. The axial cell is regarded as homologous with the endoderm of the higher animals (*Metazoa*). He designates as the ectodermic layer the cells surrounding the large single axial cell. There exists no trace of a middle layer of cells. We discover no differentiated apparatus; all the animal and vegetative functions are accomplished by the activity of the ectodermic cells and of the axial cell. On account of these characteristics, Van Beneden regards these organisms as forming the type of a new branch of the animal kingdom, which he designates *Mesozoa.*

Each species of *Dicyema* comprises two sorts of individuals differing externally, one (the *Nematogene*) producing vermiform embryos, the other (Rhombogene) infusoriform young. The Nematogenes produce germs which undergo total segmentation—assume a *gastrula* condition. After the closure of the blastopore the body elongates, the worm-like form of the adult is finally attained, and they pass through the body-walls of the parent.

The germs of the Rhombogenes arise endogenously in special cells lodged in the axial cell, and called "germigenes." The germ-cells undergo segmentation, and then form small spheres which become infusoriform embryos. The worm-like young is destined to be developed, and live in the cephalopod where it has been born, while the infusorian-like young probably performs the office of disseminating the species; it transmits the parasite of one cephalopod to another.

This work is also an important contribution to histology, particularly to the subject of cell-divisions. Says Van Beneden: "The recent researches of Auerbach, of Bütschli, of Strasburger, of Hertwich, and those that I have published, have established the fact that the division of a cellule—that is to say, the multiplication of the cellular individuality is the resultant of a long series of complex phenomena, accomplished in a determinate order, and having their seat as much in the nucleus as in the substance of the cell."

Finally, Van Beneden places in his branch of *Mesozoa* the hypothetical *Gastræades*, which term he applies to (*gastrula*-like) organisms formed of two kinds of cellules, some ectodermic, others endodermic, in which the endoderm is formed by invagination. He calls *Planu-*

lades those hypothetical mesozoa which are formed from a many-celled sphere, constituted like a *Magosphæra* (Haeckel), and in which the two cellular layers are developed by delamination. He therefore divides the animal kingdom into three primary groups—*i. e.*, the *Protozoa*, the *Mesozoa*, and the *Metazoa*.

It appears that a species of *Campanularia*, a hydroid medusa, has been found in Greenland by the *Valorous* on its return from Disco, which is said to be identical with one found by Mr. Eaton, of the British Transit of Venus Expedition, at Kerguelen Island; while the deep waters of Davis Strait afford a shell which was long since found fossil in the newer tertiary beds of Sicily, and was supposed to be extinct.

The animal of the coral, Millepora, was by the late Professor Agassiz regarded as a hydroid polyp, or jelly-fish, rather than a true coral polyp. Now, however, it has been shown by Mr. Moseley, of the *Challenger* expedition, who studied the Millepora at Bermuda, that the animal is probably a true polyp. He says that the examination of the Millepora is beset with serious difficulties; but he observed that there are large and small polyps, that both kinds have tentacles, and appear to be four in number and to be compound. Before this, however, General Nelson, of Bermuda, had made drawings of the animal of Millepora, upon which the following comments have been made by Professor Duncan, of London, in *Nature:* "It is a satisfaction for me to be able to state that General Nelson's drawings prove that Agassiz saw a part of the polyp, and that Mr. Moseley's beautiful delineations, far in advance of all, testify to the correctness of my fellow-worker. I do not credit the hydroid nature of the polyp now, any more than I did when writing the reports on the British fossil corals, and I believe Millepora to be an Actinozoan."

The effect of certain poisons on *Medusæ* is described by Mr. G. J. Romanes in the Proceedings of the Royal Society. He states that strychnia exerts a very marked influence upon them. "Of the species I have met with, *Cyanea capillata* is the most suitable for showing the effects of this poison, from the fact that in water kept at a constant temperature the normal pulsations of this animal are as regular as those of a heart. Shortly after a solution of strychnia has been added to the water in which a specimen of *C. capillata* is contained, unmistakable signs of irregularity in the pulsations of the animal supervene. This irregularity then increases more and more, until at last it grows into well-marked convulsions. The convulsions manifest themselves in the form of extreme deviations from the rhythmical character of the normal contractions, amounting, in fact, to nothing less than tonic spasms. It is further of importance to remark that the convulsions are very plainly of a paroxysmal nature, prolonged periods of uninterrupted convulsions being every now and then relieved by shorter periods of repose, during which the medusa remains perfectly motionless in a fully expanded form. *C. capillata* will live for many hours when under the influence of strychnia, but eventually death supervenes. The animal dies in full diastole."

The Bulletin of the Museum of Comparative Zoology contains notes and descriptions of some recent corals found by Mr. A. Agassiz at a height of 2900 to 3000 feet above the level of the sea, at a distance in a straight line from the Pacific Ocean of twenty miles.

That sea-urchins are sometimes viviparous, not passing through a metamorphosis, was first shown by Philippi (1845) in a South American species of *Hemiaster*. He found young sea-urchins in a sunken ambulacral area of the adult, and regarded them as the young of the Hemiaster. Lately it has been discovered by Grube that the young of *Anochanus*, a genus of sea-urchins occurring in the East Indies, live under similar conditions. During the present year Mr. A. Agassiz has examined some Hemiasters brought home by Dr. J. H. Kidder, the naturalist of the Transit of Venus Expedition, from Kerguelen Island, and finds that they are viviparous, the eggs (or the imperfectly developed pluteus or larva) probably escaping from the genital openings, readily finding their way into the artificial cavity formed by the spines which conceal the presence of the sunken areas, which serve as brood cavities.

M. L. Fredericq has studied the anatomy and histology of the nervous and muscular system of Echini. He finds, as stated in a communication made to the French Academy, that the pentagonal nervous ring which surrounds the œsophagus, and the five ambulacral cords which go from it, are contained within a special system of canals which can be readily observed. The famous eye-like spots he claims only exist in the imagination of those who invented them. The nervous ring and the large trunks which are sent off from them are identical in structure, and should be considered as nervous centres. The muscles are formed of very fine fibres, which are cylindrical, entirely smooth and homogeneous throughout, with no enveloping membrane. M. E. Perrier has also published (*Archives de Zoologie*) researches on the circulatory system of Echini; while, in the *Archiv für microskopische Anatomie*, Professor Alexander Goette gives the developmental history of *Comatula Mediterraniensis;* while Dr. R. Teuscher describes the minute anatomy of Comatula and the sand-stars (Ophiuridæ). A new *Peripatus* has been found in New Zealand by Captain F. W. Hutton, who calls it *Peripatus Novæ-Zealandiæ*. This animal is a worm with tracheal or respiratory tubes in the young stages, and is thus a connecting link between the insects and worms.

During the spring of the year humble-bees are in Europe infested by great numbers of a minute worm, called by Dufour *Sphærularia Bombi*. Says Mr. Cole, in the *Journal* of the Quickett Microscopical Club: "The Sphærulariæ are not found, as is commonly the case with the mature entozoa, in the interior of the alimentary canal. They lie perfectly free among the viscera in the upper portion of the abdominal cavity, and are bathed on all sides with the nutritive fluids of the bee. They are generally more or less coiled up, and are absolutely without motion. They have thus far only been found in female bees. The mature female Sphærulariæ are about an inch in length; while the males, as they are regarded by Lubbock and others, are very minute, being about one twentieth of an inch long, or about ten thousand times smaller than the females. They seem to be almost invariably attached near the head of the females. A German observer (Schneider) believes the so-called female to be merely the enlarged oviduct of the small worm, which he regards as the true female.

Dr. Cobbold continues, in the Proceedings of the Zoological Society, his illustrated notes on the *Entozoa*.

The unarmed Gephyrean worms, such as the various species of Sipunculus, have been studied in part anatomically by H. Théel; while MM. Marion and Bobretzky have investigated the worms of the Mediterranean Sea.

One of the most important discoveries in zoology of the past year is the curious fact regarding the development of the Salpa of our coast. Mr. W. K. Brooks finds that in this animal, which occurs on the southern shores of New England, and swims either solitary or in chain-like aggregations of individuals, the solitary individuals are females, while the individuals which make up the chain are males. The solitary female produces a chain of males by budding, and discharges an egg into each before birth. These eggs are impregnated while the animals composing the chain are small and sexually immature, and develop into females, which give rise to other males by budding. After the embryo has been discharged from the body of the male, the latter grows up, becomes sexually mature, and discharges its seminal fluid into the water, by means of which it is carried to the eggs within the bodies of younger chains. This is quite a different mode of growth from that suggested over a century ago by the poet Chamisso.

A singular animal has been discovered, at the depth of fifty fathoms, by Mr. Tycho Tullberg, among the islands and fiords of the western coast of Sweden. After giving a lengthy review of its external appearance and anatomy, the author hesitates at present to offer any opinion as to the systematic position of the animal, though he ventures the remark that the type of mollusca and that of vermes seem both to claim *Neomenia* as a distant relation, the latter, perhaps, with more right than the former. *Neomenia*, however, presents considerable deviations from both, in the absence of a radula, in the structure of the alimentary canal and of the nervous system, as also in other respects, as the form of the body and the spines on the skin.

Excellent plates accompany the article, which is written in the English language.

The embryology of the mollusks has been studied by Fol, Ray-Lankester, Rabl, Jhering, and Bobretzky; while Professor Leydig has published, in Troschel's *Archiv*, an elaborate account of the shells and tegumentary coverings of the gastropod mollusks. Rabl's paper on the development of *Unio*, in the *Jenaische Zeitschrift*, is especially noteworthy.

An interesting article on the habits of the singular fluviatile shell *Io* is contributed to the *American Naturalist* by Dr. Lewis. They live in the rivers of Tennessee, and are so solid and of such bright colors that they might be mistaken for sea-shells. It seems that they were known to the Indians before the advent of European races, as they have been found in their graves.

The last annual report of Professor Hayden's United States Geological Survey contains an excellent account of the snails collected in Colorado by Mr. E. Ingersoll. Six new species were collected, and much interesting information given regarding the vertical distribution of the species found.

Besides Rabl's later paper, a very fully illustrated memoir on the development of the fresh-water mussels (*Unio* and *Anodonta*) of Europe, by W. Flemming, had been previously published in the Proceedings of the Royal Academy of Science of Vienna for 1875. The papers will interest American students, since these mussels so abound in our rivers. Similar but less extended researches have been carried on in this country by Dr. W. K. Brooks, but we believe they are as yet unpublished.

The great work of Mr. F. B. Meek on the "Invertebrate Cretaceous and Tertiary Fossils of the Upper Missouri" is illustrated by forty-five plates, and treats principally of fossil mollusks. It will be indispensable to the geologist of the far West, as the different divisions of the cretaceous and tertiary ages were originally established by the invertebrate remains therein described, and it therefore forms the basis of our knowledge of the two most important formations in the West.

A large volume on the fauna of the land and fresh-water shells of Northeastern Africa, by Carl F. Jickeli, has recently appeared. A number of forms, reaching as far south as Zanzibar, are included. The work is accompanied by eleven excellent plates. Though bearing date 1874, it has only recently been received in this country.

Dr. W. K. Brooks, in a paper entitled "Affinity of the Mollusca and Molluscoida" (polyzoa and brachiopods), suggests that the tunicates are not mollusks, and that the polyzoa and brachiopods are derived from the worms. He also, as others have suggested, thinks that the mollusks are also derived from the worms. He believes that the polyzoa originated from a type like the brachiopods. Thus it would seem, he says, "not only that the mollusca and molluscoida (polyzoa and brachiopods) are related, but that they are connected so closely that the advisability of such a division is very doubtful." He does not believe that the lamellibranchs are typical mollusks, but that the gasteropods should be considered so, and that the lamellibranchs are derivations from them.

Dr. Rabl gives an account of the embryological development of certain pond snails belonging to the genera *Lymnæus*, *Physa*, *Planorbis*, and *Ancylus*. These investigations are of interest from the clearness with which the "gastrula" stage is presented in *Lymnæus ovatus*, the same phase ("invaginate gastrula") being much more obscurely marked in *Lymnæus stagnalis*, as observed by Ray-Lankester. It appears that all the fresh-water pulmonates whose development has thus far been observed have the same general mode of growth.

The mode of development of the garden snails of Europe (*Helix pomatia* and *H. nemoralis*) is discussed in an elaborate manner by Dr. Hermann von Jhering, so that now we have tolerably full knowledge of the mode of growth of the land and fresh-water snails.

M. Gerbe finds that oysters are fitted for reproduction from the first year of their life. Among these precocious mothers there are some whose shell, in transverse diameter, measures hardly twenty-five millimeters. Hence the prosperity of the reproducing portion of a natural oyster-bed does not depend only on the presence of large oysters. The quantity of eggs, indeed, is generally in proportion to the size of the oyster. Many oysters, especially the young, propagate twice in the season, under favorable conditions. The laying of eggs occurs at long intervals, possibly corresponding to lunar phases.

Within two years many important works on shells and shell-fish have been published in Europe; while in this country it would appear as if our conchologists were resting on their oars. The deformities of mollusks and their shells have formed the subject of a work by Clessin. He divides the subject into three categories: (1) Monstrosities, being changes in shape of considerable amount, limited to the animal; (2) modifications in the shell caused by affections of the living organs from without; and (3) anomalies in shells caused by mechanical injuries, not affecting the animal.

An elaborate memoir, by Professor Steenstrup, on the cuttle-fishes, with a description, accompanied by beautiful plates, of a new form (Hemisepius), appears in the Memoirs of the Royal Danish Academy. This singular short cuttle-fish was discovered at Table Bay, Cape of Good Hope.

The shells collected by Dr. Kidder, naturalist of the Transit of Venus Expedition, at Kerguelen Land, have been, according to the *American Naturalist*, worked up by Mr. W. H. Dall, who describes three new genera. One of these was described in England under the name *Eatonia;* but as this name was long since preoccupied by

Professor Hall for a genus of brachiopods, the name *Eatoniella* is substituted. Mr. Dall also describes a genus allied to *Ceropsis* of the *Carditidæ*, giving it the name *Kidderia*, in honor of the naturalist of the expedition. A new genus of chitons is described by Dr. P. P. Carpenter under the name *Hemiarthrum*.

Mr. W. H. Dall describes the way in which the eggs are set free from the ovisac and cavity of the body of the limpets, in which no opening could be found. The minute size and fragility of all the parts was one obstacle. Not long ago, however, Mr. Dall had an opportunity to dissect several limpets of extraordinary size which Professor Agassiz brought home from the *Hassler* expedition, and found one in which the ovaries were full of eggs. He has observed that those eggs which lay at the extremities of the ovisac nearest the renal sacs were granulated, congested, and much riper than the rest, and that very minute orifices allowed of communication between the ovisac and the renal sac. Further examination showed still riper eggs in the renal sac itself, and, as it were, drifting toward the external opening, through which they passed into the sea-water.

The Academy of Sciences has received from M. P. Fischer a paper on the hypsometric distribution of mollusca—that is, the altitudes at which they are found. It is a striking fact, says Galignani, that plants thrive on mountains with great regularity, each at a certain height. Every species has its peculiar habitat, and if the mountain exceeds 8000 or 9000 feet, vegetable life gradually disappears near the summit. The terrestrial mollusca, being unprovided with means of locomotion enjoyed by birds and insects, and being, moreover, dependent upon vegetable life for food, could not, our author thinks, fail to be distributed in the same way as plants, and this supposition is confirmed by observation. Each species extends to an altitude the limits of which it does not overstep. M. Fischer has verified this in the Central Pyrenees as well as in the Alps, and divided the altitudes into five zones, comprised between 1500 and 7500 feet. Each zone is distinguished by the name of a species of *Helix*. Thus in the Pyrenees the first zone, ending at a height of 3000 feet, is called that of *Helix carthusiana;* the second, ending at 3600 feet, *H. aspersa;* the third, terminating at 4500 feet, *H. limbata;* the fourth, limited at 6000 feet, *H. nemoralis;* and the fifth, ending at 7500 feet, *H. carascalensis*. In the Alps, at the same altitudes, the names of the zones are respectively *Helix carthusiana*, *obvoluta*, *Fontenelli*, *sylvatica*, and *glacialis*. A few individual mollusks may, indeed, climb as high as 9000 feet, but they will stop at the limit of perpetual snow. Various genera of fluviatile mollusks do not ascend higher than 3000 feet—a circumstance of some importance to geologists, since it proves that in the quaternary beds the fossiliferous strata containing those genera, such as *Neritina*, etc., were deposited at small altitudes.

Many fish are afflicted by crustaceous parasites, called Argulus, which adhere to the gills. Dr. Claus has recently published an elaborate description of the variable form known as *Argulus foliaceus*. It is a parasite on a great variety of fishes, also on toads and tadpoles, and even on the axolotl or larval salamander.

The habits and nature of the limbs of trilobites is a matter about which there is much difference of opinion among naturalists. Some consider that they had broad, leaf-like swimming appendages; while others think they were like the modern Serolis, a sowbug-like form; and others compare them to the horseshoe crab, which both burrows and swims, walking through the mud, and at times swimming on its back, by means of its broad, leaf-like, abdominal feet. As a contribution of some value to this subject is a paper by Mr. C. D. Walcott, printed in the Annals of the New York Academy of Sciences, formerly the Lyceum of Natural History. His observations, based on the examination of 1160 specimens, lead him to believe, with Burmeister, that they swam on their backs, as out of 1160 specimens 1110 lay on their backs. The author seems to agree with the following conclusions, reached by Burmeister: (1) that these animals moved only by swimming, that they remained close beneath the surface of the water, and that they certainly did not creep about at the bottom; (2) that they swam in an inverted position, the belly upward, the back downward, and that they made use of their power of rolling themselves into a ball as a defense against attacks from above; and (3) that they most probably did not inhabit the open seas, but the vicinities of coasts, in shallow water, and that they here lived gregariously, in vast numbers.

The reproductive organs of the decapod *Crustacea* have been studied afresh by M. Brocchi, who concludes that neither the position nor the form of the genital orifices can furnish characters for classifying the macrourous forms (lobsters and shrimps), while in the crabs they are, with the external organs, of value for distinguishing families and species. References are made to works on this subject by the American naturalists Stimpson and Ordway.

The volume on parasitic animals, by Professor Van Beneden, lately published, will introduce our readers to the subject of commensalism. A new example is given by Dr. Streets in the *American Naturalist*, in the case of a crab found living in the cloacal dilatation of the alimentary canal of a sea-cucumber or holothurian living among the islands of the Pacific Ocean. The crab belongs to the family *Portunidæ*, or swimming-crabs, though an aberrant form. It is not only a new species, but, with another species found by Dana at the Fiji Islands, forms the type of a new genus.

It has been asserted by Bell, contrary to the supposition of Vaughan-Thompson, that the young of the land-crabs, like the lobster and crawfish, have the same form when hatched as their parents. The late Dr. Suhm, of the *Challenger* expedition, however, found some eggs of a land-crab belonging to the genus *Cardiosoma* containing young ones which "were not like their mother, but zoeäs." It is probable that the larvæ, called zoeæ, leave the mother, and lead a pelagic life until they have undergone all their wonderful metamorphoses.

Some facts regarding the habits in confinement of the blind crawfish of the Mammoth Cave, and the restoration of lost parts, are given by Mr. F. W. Putnam in the Proceedings of the Boston Society of Natural History.

The classifications of the Scorpions have been revised by Professor T. Thorell, his arrangement being based on that of Peters. It seems that there are about ninety species of scorpions in existence.

Ascending to the insects, besides many papers describing new forms by leading American and European entomologists, we would call special attention to certain new general discoveries.

The embryology of the flea, *Pulex felis*, has been studied anew by Balbiani. So far as the long abstract published of his work is concerned, no mention is made of an essay on this subject, illustrated with numerous figures, by the writer, published in 1872 in the Memoirs of the Peabody Academy of Science, wherein a number of facts supposed by Balbiani to be new are mentioned.

The embryo of the white ant (*Calotermes*) has for the first time been figured by Fritz Müller in the Jena *Journal of Science*. From this single figure it would seem that the white ant is similar in its mode of development to other insects, especially the dragon-flies.

Papers on the fossil insects of Colorado and Nova Scotia have appeared from the pen of Mr. Scudder, and several new European fossil insects have been described in foreign journals. Mr. Scudder calls attention in the *Geological Magazine* to the "constant discovery of close relationship between the ancient forms of insect-life in Europe and America, which Mr. Woodward has been one of the most conspicuous in pointing out." A list of described orthopterous American insects from the Carboniferous formation, by Mr. Scudder, appears in the same connection.

We have already referred to Weismann's remarkable paper on seasonal dimorphism, and to the fact that important data regarding the varieties of *Papilio Ajax* of this country were afforded by Mr. W. H. Edwards, the author of the beautiful work on butterflies now being published in this country. Further experiments are detailed in the *Canadian Entomologist* for December, which has just appeared. Mr. Edwards' paper will prove exceedingly interesting. He subjected a large number of chrysalids of what would have produced the variety Marcellus to severe cold in an ice-house, and found that the cold completely changed a part of them to Telamonides. He regards the variety Telamonides as the primary form of the species. We thus have in this and similar experiments examples of the artificial breeding of different varieties of insects at will, and it is not impossible that results of a practical nature may follow when applied to some of our injurious species.

The relation of bees to flowers is discussed by Hermann Müller in a paper translated in *Nature*. He calls attention to the interesting facts presented by various groups of *Hymenoptera*, in which occur a series of forms presenting more and more complex life relations, accompanied by a higher and higher mental organization. The consideration of these gradations is calculated to throw much light on the question, "How has the honey-bee acquired its remarkable instincts?"—a question which the study of that species alone would, in his opinion, do little to solve, but on which the habits and organization of the lower group throw much light. Dr. Müller, after giving the evolutional history of the sting of the wasp, tracing it up from the ovipositor of the ichneumon-fly and saw-fly, thinks that the various acts by which the solitary wasps protect their young must have at first been arrived at with a consciousness of the object to be effected, but that they have gradually become instinctive, and are now unconsciously inherited from generation to generation. "Still it is," he observes, "impossible to watch a wasp at work without feeling that, with these inherited customs or so-called instinct, much individual effort also comes into play."

Mr. Riley's eighth report on the noxious and beneficial insects of Missouri contains much valuable information regarding the common and more injurious insects of the Western States, particularly the Colorado potato-beetle, canker-worm, army-worm, the Rocky Mountain locust, and the grape phylloxera. Public attention is annually turned to these destructive pests; and the careful studies of Mr. Riley, set forth in clear, forcible language, will do much toward enlightening the agricultural mind. If the other states were as intelligent and liberal in providing for the publication of such reports, co-operation could be secured between the inhabitants of different states, and the more injurious insects combated and held at bay.

Among other new entomological tracts are Baron Osten-Sacken's "Prodrome of a Monograph of the Tabanidæ of the United States," in which it is stated that there are 102 species of horse-fly (*Tabanus*) in America north of Mexico, of which twenty are new to science.

Mr. Scudder publishes in the Bulletin of the Buffalo Society of Sciences the second part of his synonymic list of the butterflies of North America, and in the *Canadian Naturalist* figures and describes the hind body of the larva of a dragon-fly and a part of the wing of a cockroach from the carboniferous formation of Cape Breton.

Dr. Hagen describes some curious insect deformities, such as butterflies with caterpillar heads, etc., in the Memoirs of the Museum of Comparative Zoology.

The young or larvæ of certain cave beetles from the Mammoth and adjoining caves are figured and briefly described by Dr. Packard in the *American Naturalist* for May. It appears that the young as well as the adult beetles are blind, otherwise they do not differ much from the young of allied genera. The beetles are *Adelops* and *Anophthalmus*. Besides these, a blind coleopterous larva belonging to an unknown species was discovered in the Carter caves in Eastern Kentucky. Remarks are also made on the degree of variation in these cave insects, which seems due more to varying means of subsistence than any other cause. The amount of variation, however, is very slight.

It has been found that certain Australian moths are capable of puncturing orange-skins by means of their proboscis or spiral tongue. It seems that the ends of the two halves of the tongue are stiff and barbed, and present on the under side three parts of the thread of a screw, while their sides on the upper surface are covered with short spines, springing from a depression, with sharp, hard sides. The object of these spines is to tear the cells and the pulp of the orange, as a rasp opens those of beet-root, to extract the sugar.

A writer in the *American Naturalist* notices an interesting instance of intelligence in the hawk-moth (Sphinx). While watching the sudden unfolding of the flowers of the *Œnothera Lamarkiana*, he observed that the hawk-moths never visited the same flower twice, even when frightened away by some motion made by the observer. On returning, they would go only to those flowers that had opened during their absence or that had not been visited before their flight.

In the fifth Bulletin of Hayden's United States Geological Survey of the Territories is a list of the bugs (Hemiptera) of the region west of the Mississippi River by Mr. Uhler, who has for so many years devoted himself to these insects. A number of new forms are described. The article is made still more useful by the addition of three excellent plates.

Professor Stoll, of Stockholm, has published an extensive work on the hemipterous insects of the world, one half of the work relating to those of North and South America.

Professor Riley's "Notes on the Yucca Borer" (*Megathymus yuccæ*), reprinted from the Transactions of the Academy of Science of St. Louis, is an interesting account, well illustrated, of a butterfly which bores into the root, tunneling it for most of its length. The insect is sufficiently common in the Gulf States to be sometimes found in every third plant over extended regions, its work rendering the yucca worthless as a hedge plant.

The geometrid moths, numbering in the United States some four hundred species already known, have been monographed by the writer, in a quarto work of over six hundred pages, with thirteen plates, forming Vol. X. of Hayden's reports of the United States Geological and Geographical Survey of the Territories. The descriptive portion is preceded by chapters on the anatomy of the head and thorax, on secondary sexual characters, etc., while the volume closes with an essay on the geographical distribution of the species in this country.

It is generally supposed that, while the tropics abound in large, strong insects, there are not so many kinds like those of temperate regions—small and of modest colors. It appears, however, that the number of small forms is as great as in the temperate zone. For example, of the family of Rove beetles (Staphylinidæ) Dr. Sharpe estimates the probable number existing in the valley of the Amazon at from 4000 to 5000. And Mr. H. W. Bates, who spent several years (we believe nine) on the Amazon, states his belief that the proportion the smaller forms bear to the larger is as great in Brazil as in Europe; but the larger forms were, of course, more commonly captured in a country where so many new and fine species were to be found.

New observations on the mode of respiration of the water-boatman (*Notonecta undulata*) have been published by the writer, in "Half-Hours with Insects." This insect is boat-shaped, the keel of the boat being its back, the deck its ventral aspect. Along the middle of the under side of the body is a longitudinal ridge; a broad gutter between this ridge and the sharp edge of the body is bridged over from the head to the abdomen by a layer of dark, coarse, oblique hairs, and a layer of less oblique hairs arises on each side from the middle of the ridge. These hairs thus form a false upper deck. The creature rises to the surface, the end of the body projecting slightly out of water; the air passes up on each side along the tunnel under the hairs, and collects in bubbles above the base of the legs. Along the bottom of this tunnel are six pairs of spiracles into which the air passes. The air in the specimens he observed did not adhere to the hairs of the hind-legs, as Siebold says it does, nor, as he states in his "Comparative Anatomy," translated by Burnett, does the air for respiration as a rule pass under the elytra, since the spiracles are not situated on the upper side of the body, but on the under, and quite a distance from the edge of the body. Nor does this insect breathe at all, as Westwood states, like Dytiscus, in which the spiracles are situated on the upper side of the body, so that the air enters readily under the elytra. When it takes in the air, the tip of the abdomen is thrust up just above water, and an orifice is formed by the separation of the hairs at the end of the keel, which form the larger part of the mouth of the orifice, the remainder being composed of the hairs fringing the movable terminal plates of the body. The air thus passes in between the false deck of hairs and the under side of the body. When the insect is taken out of the water the hairs cling to the sides of the body, revealing very distinctly the breathing-holes. Some air occasionally penetrates under the elytra, and remains there most of the time. Often the whole under side of the body between the pairs of legs is a continuous bubble, like a mass of quicksilver or molten lead. The *Notonecta* often rises for a new supply of air before the old is exhausted.

Another water-bug, the *Corixa*, is less tame, and does not come to the surface nearly as often as *Notonecta*. It receives its supply of air in an instant, and darts down to the bottom. It does not swim in an inverted position. It takes in the air so suddenly that it is impossible without patient observation to see the mode, which has not been described. It rises to the surface in a horizontal position, and no sooner is the surface reached than it darts to the bottom, and in one instance remained there for ten minutes, and then darted up again, leaving an air bubble in its wake, which rose to the top afterward. It carries down with it a broad, silvery streak along the side of the body. The air is really introduced under the head and front thorax. The head is large and very movable, as well as the prothorax. It slides back and forth on a thin membrane, from the surface of which it can be raised. So with the hinder edge of the prothorax, which rides over the membranous hind thorax, which it nearly conceals. When the *Corixa* rises to the surface it floats in a horizontal position, the hind edge of the head and the prothorax rising slightly above the surface. Now slightly raising the back of the head and the hind edges of the prothorax, a space appears in front of and behind the prothorax, by which the air passes into the breathing-holes beneath. This is proved by the small bubbles of air remaining in these two cracks. Two minute spiracles may be detected in deep pits, one on each side, just above the insertion of the legs, and from which the tracheæ arise, each one dividing into three irregular short branches, as may be seen by detaching the segment and holding it up to the light.

VERTEBRATE ZOOLOGY.

BY DR. THEODORE GILL.

Vertebrate Zoology has received the average amount of attention devoted to it for the last few years. Valuable contributions have been made to the morphology and anatomy of the branch, and its several classes; numerous species have also been added; and several very interesting new types have been made known. Unquestionably the most noteworthy of these are several forms collected in the Australian and Ethiopian realms: these are (1) a species of the genus *Tachyglossus* or *Echidna*, which has been supposed hitherto to have been confined to Australia and Van Diemen's Land; (2) a remarkable new generic type, representing a previously unknown family, found in Africa; and (3) a second genus of the hitherto monotypic class of Leptocardians. The significance of these discoveries will be made manifest in our subsequent remarks.

Almost if not quite the most interesting of animals has been the *Branchiostoma lanceolatum* (often called *Amphioxus lanceolatus*), until lately the type of the only known genus of not only a class, but even, in the opinion of many, a primary group or "superclass" of the branch of vertebrates. The genus owes its interest and importance to the fact that it is, to most intents and purposes, an "invertebrate vertebrate;" and that it gives, in its organization, the chief if not the only clew to the derivation of the vertebrate phylum in its differentiation from the mass of the animal kingdom. Through the careful study of that interesting form, naturalists had arrived at the conclusion that the vertebrates were derived in all probability from the molluscoid Tunicates. Unusual interest is, therefore, attached to the discovery of an apparently well-defined second genus of the family. Its type was discovered in Moreton Bay, North Australia, by the captain of the German Imperial vessel *Gazelle*. The new genus differs from *Branchiostoma* in the development of a high dorsal fin; in the want of a distinct caudal as well as anal fin; and in the symmetrical median (not lateral) position of the anal aperture. It appears also to present some differences of detail in the structure of the mouth and oral tentacles; but these characters require yet to be elucidated. The type of the genus is much smaller than the species of the genus *Branchiostoma*. Ten specimens obtained vary from thirteen to twenty-three millimeters in length. The newly discovered type has been described by Dr. Peters, of Berlin, under the name of *Epigonichthys cultellus*. The generic name was apparently given in allusion to the type being the second of its class made known (ἐπίγονος, later born, or born of a second marriage, and ἰχθύς, fish).

Notable contributions to ichthyology have been made relative to the groups as well as to the faunas of several countries.

A new form of fishes was discovered by Herr Buchholz in a small stream in Victoria, emptying into the Victoria River, in West Africa. The species is of small size, and in external appearance has considerable resemblance to a Cyprinodont, and especially to species of the genus *Haplochilus:* it is really, however, closely related to the *Osteoglossids* of South America and Australia, and has no real affinity with the *Cyprinodontids:* it is covered with cycloid scales, furnished with the radiating fracture-like markings characteristic of the Osteoglossoid series; its head is flattened above; its cheek protected by the enlarged suborbital bones; no interoperculum or suboperculum are developed; the mouth is very fully provided with teeth; the dorsal fin is situated far behind, and is very short and high; the anal fin is also short, but more developed than the dorsal, and more anterior; the ventral fins are rather far advanced forward, although, of course, still abdominal. The relations of the type are evidently with the family with which it has been compared—*i. e.*, the osteoglossids; and the importance of its discovery is due chiefly to this affinity. It has been claimed by several observers that there is in many respects a close relationship between the African and South American faunas, and that this relationship is evidence of the former closer connection of the two continents; these as well as the Australian continent furnish not a few proofs that they have derived their animal inhabitants from a common but very remote primitive source. The newly discovered fish furnishes another decided argument in favor of the truth of this view. It has been named *Pantodon* (in allusion to the numerous teeth) *Buchholzi.*

A characteristic type of fishes of the Northern Atlantic is exemplified in the species variously called "Sea-Wolf," "Wolf-fish," and "Cat-fish." This species (the *Anarrhicas lupus* of naturalists) is common to both sides of the Atlantic, and is well known in connection with its powerful jaws, and its consequent ability to wound and otherwise injure fishermen. The other species of the genus have been involved in considerable obscurity. In the past year, however, Professor Steenstrup has published, in Danish, a monograph of the genus, in which he has demonstrated that in the extreme northern seas, and especially the Greenland waters, no less than four species are found, which represent two quite distinct minor types or subgenera, one (*Anarrhicas* proper) containing two species (*A. lupus* and *A. minor*), and the other (*Lycichthys*) containing also two, but less known species (*A. latifrons* and *A. denticulatus*).

Among the contributions to knowledge of the Ichthyic faunas of various countries, probably the most interesting are respectively the monograph of the fishes of the Aralo-Caspio-Euxine basin, by Professor Kessler; the Catalogue of the Fishes of the Bermudas, by Professor G. Brown Goode; and the summary of the fishes of the high mountainous lake of Peru, Titicaca, by Mr. S. Garman. These owe their interest to the isolated positions or other geographical relations of the regions in question.

The number of fishes in the great interior basin first alluded to is unexpectedly large, considering the latitude and character of the surrounding country; about 280 have been recognized by Professor Kessler. Doubtless the most interesting development, to Americans at least, is the discovery of not less than three species of the genus *Scaphorhynchus* (a genus belonging to the sturgeon family), of which, until lately, but one species had been known, and that a familiar inhabitant of the Mississippi Valley.

Nothing of a special interesting or novel nature has been published on the class of Amphibians.

In the class of reptiles, the discovery of a second species, or at least supposed species, of the genus *Sphenodon*, or *Hatteria*, deserves notice. The genus *Sphenodon* had hitherto only been known to contain one species, and that the sole existing representative of a formerly richly developed order. The first species appears to be confined to Karewa Island, in the Bay of Plenty, New Zealand; and the second species has been discovered in the Brother Island, also of the New Zealand archipelago.

In Ornithology quite a number of valuable contributions have been made to the morphology and taxonomy of various groups by Garrod, Kidder, Coues, and others; and the faunas of a number of countries have received attention from systematic ornithologists.

One of the most interesting publications on classification is a monograph on *Chionis* and its relations, by Drs. Kidder and Coues. This genus is confined to the southern hemisphere, where it is represented by two species; one found at the extremity of South America, etc., and the other on Kerguelen Island, etc. The affinities of this form were long involved in much doubt: it had, according to some, passerine relations; according to others, gallinaceous ones; but, in the opinion of most recent ornithologists, it was most nearly related to the plover-like birds, and especially the genus *Hæmatopus*. It now appears, however, from the investigations of Kidder and Coues, that it is nearer of kin to the gulls than any other birds; but that its relations, to some extent, are intermediate between the plovers and the gulls. The authors cited have therefore recognized it as the type of a primary group or "super-family" of birds under the name of *Chionomorphæ*, which is intercalated between the *Charadriomorphæ* and *Cecomorphæ*.

The contributions to our knowledge of the avifaunas of regions have been, as has been the wont for a number of years, quite multitudinous. Among them three may be especially enumerated on account of the interesting nature of the regions in question, as well as in connection with a certain law of development which they suggest: these are respectively a catalogue of the birds of the Galapagos Archipelago, by Mr. Salvin; a descriptive list of the species of the Californian Guadelupe Islands, by Mr. Ridgway; and an article upon the parrots of the Mascarene Islands, by Professor Newton.

Mr. Osbert Salvin, in his memoir "on the Avifauna of the Galapagos Archipelago," adds much to the information previously possessed of the birds of that remarkable group of islands. These islands are about fifteen in number, and are clustered under the equator about 600 miles west of the coast of South America. They are remarkable for the number of peculiar species of birds. Fifty-seven are now known from the different islands, thirty-eight of which are peculiar to one or more of them, and only nineteen (and those mostly water-birds, or species possessing great power of flight) have been found elsewhere. These fifty-seven species represent thirty-nine genera, of which five are peculiar to the islands, seven are common to them and the contiguous coast of America, and the remaining twenty-seven are types of wide distribution. The entire avifauna is a striking exemplification of the modifications concomitant with isolation and peculiar conditions.

Mr. Ridgway's article "on the Ornithology of Guadelupe Island" was "based on notes and collections made by Dr. Edward Palmer." The Guadelupe Island meant is situated between latitudes 28° 45′ and 29° 10′ north, and is distant about 220 miles southwest from San Diego. The species known are but few in number, only eleven land-birds having been identified; and of these only eight are known from specimens. All of those thus known are either distinct specifically, or as varieties, although, as was of course to be expected, they are congeneric with and near allies to species of the adjacent mainland.

The extent to which certain groups are developed under exceptional conditions, and their liability to extermination on the intrusion of extraneous agents, have been well exemplified in the history of the Mascarene Islands. These islands, including Mauritius, Reunion, Rodriguez, and the Seychelles, were within the historical period the abode of some remarkable birds, among which the Dodo and the Solitaire were the most conspicuous. These were uncouth small-winged birds which lived on the ground and attained a large size, and this development was doubtless due to the absence of carnivorous mammals or other formidable enemies. The history of their extermination is familiar to naturalists; but it is not so well known that other birds have undergone or are now approaching a similar fate. Some of these were also imperfectly endowed with power of flight. One group thus affected has been lately elucidated by Messrs. A. and E. Newton in a memoir "on the Psittaci of the Mascarene Islands." It appears that each of the four islands of that group had at one time at least two species of parrots, among which were even two generic types; one (*Necropsittacus rodericanus*) confined to Rodriguez, and another (*Lophopsittacus mauritianus*) restricted to Mauritius. These two are now known only from their fossil remains—save that in one case (*Lophopsittacus*) the external characters are traceable from a figure made by an old Dutch traveler. The other species have also become exterminated, or exist in diminished numbers. Thus in Mauritius one is entirely extinct, and another exists in decreased numbers; from Reunion two formerly indigenous species have entirely disappeared; in Rodriguez one species is now also entirely extinct, and another nearly so; and only in the Seychelles Islands are the two species found in any number, but even they are receding, and apparently doomed to the fate of their relatives.

A study of these several memoirs, and the data on which they are based, and especially a comparison of the measurements of the insular species thus referred to with those of continental areas, reveals the fact that the island forms have at least a decided tendency to abbreviation of the wings and development of the legs in proportion to each other as well as to the bill. These characteristics, it is true, have not been adverted to in the memoirs enumerated; but they become evident upon a comparative examination of the species signalized by them and allied continental ones. The restriction of the areas and the paucity of carnivorous enemies, which detract from the necessity of flight, and induce the greater use of means of terrestrial progression, are doubtless the determining causes of these peculiarities.

For the class of mammals one discovery merits special mention, and several monographs of different families or genera of special interest have been published.

The order of *Monotremes*, the lowest and most generalized type of mammals, and which differs in the most marked manner from all other types of the class, has hitherto been supposed to be confined to Australia in the present geological epoch. In that continent it has furnished two very distinct forms or representatives of distinct families—*Tachyglossus*, or *Echidna*, and *Ornithorhynchus*. During the past year, however, the collectors of Mr. Bruijn, of Ternate, obtained from natives, on a peak of the Arfaks called Mickerbo, in the island of New Guinea, two imperfect skulls of a mammal which evidently is a typical member of the family *Tachyglossidæ*. This has very lately (December 3, 1876) been described by Messrs. W. Peters and G. Doria as a new species of the genus *Tachyglossus*, under the name *T. Bruijnii*. It nevertheless differs markedly from the *T. hystrix* and *T. setosus* of Australia in the much more elongated and nearly uniformly or very gradually attenuated and decurved rostrum, as well as in the contour of the palate, etc. So great are these differences that consistency with the generally accepted canons regulating generic differentiation among the mammals necessitates the expression of those differences in nomenclature by special generic designations, and the newly discovered form may therefore be appropriately contrasted under the name *Zaglossus* (Ζα, augmentative particle, and γλοσσα, tongue) *Bruijnii*, with the previously known *Tachyglossus hystrix* and *Tachyglossus setosus*. The Papuan species is very much larger than the Australian ones, and was described by the natives as being about as large as a dog, and having a decided tail, and long, harsh fur. The external characters therefore, probably, also contrast with those of the Australian animals. The species is highly esteemed by the Papuans as food, and is hunted down by dogs. It conceals itself in small caves, and must be either rare or difficult to catch, as the hunters of Mr. Bruijn were unable to obtain more than the two skulls referred to.

Of the monographs published the most noteworthy are those of Professor Flower, on the existing species of Rhinoceros, and Mr. J. A. Allen, on the existing and extinct species of Bison of the American continent. Mr. Alston's memoir on the classification of the Order of Rodents will also be found to be of service.

Having thus given some idea of the principal contributions to the knowledge of existing vertebrate faunas, we now pass to the consideration of a few of those elucidating the extinct faunas. Our restricted limits permit us only to do little more than refer to those relative to the animals which formerly inhabited the countries at present embraced within the limits of the United States. These contributions have been chiefly, as for several years past, by Marsh, Cope, and Leidy.

During the period immediately preceding our own, the terrestrial vertebrates that ranged over our territories were essentially the same as those that now live here; it has been shown, however, that on the whole the mammals at least were larger in size. This was first proved, on a considerable scale, by Professor Baird, and recent results have corroborated his conclusions. In 1876 Mr. J. A. Allen described, from the lead-bearing regions of Illinois, the remains of a deer and wolf analogous respectively to our recent *Cariacus virginianus* and *Canis lupus*, but which are considerably larger, thus confirming the generalizations already enunciated.

In the Miocene epoch existed a fauna quite different from our present one. The forms that then flourished, and which were among the most characteristic of the time, apparently died out with that epoch, without leaving any lineal descendants. One of the most remarkable of the forms of the Lower Miocene was a peculiar type of mammals related to the family of Rhinocerotids of the present time, which latter are now confined to the tropical parts of the so-called Old World. In past periods, however, that family was well represented within the present boundaries of the United States; and at a still more remote period—*i. e.*, in the Lower Miocene—forms related to the living type, but which were differentiated by quite distinct characters, and which were very closely related to at least the progenitors of the recent Rhinocerotids, existed in numbers in what is now Western America. This type, which has been distinguished as a family by Professor Marsh under the name of Brontotheriids, was closely related to the Rhinocerotids, but differed in details of dentition and the feet, as well as the armature of the head. The typical species, at least, were provided with horns, arising not from the median line, as in the present Rhinocerotids, but from each side of the nose. The brain was also very much smaller than that of the Rhinocerotids of the present epoch. According to Professor Marsh, four generic types can be recognized: these have been distinguished under the names (1) *Menodus* or *Titanotherium*, (2) *Megacerops*, (3) *Brontotherium*, and (4) *Diconodon*. These are again combinable into two groups, one composed of the first and second, and the other of the third and fourth genera. All the known remains of the family have been obtained from east of the Rocky Mountains, in the Lower Miocene beds of Dakota, Wyoming, and Colorado. It is quite possible, however, if not probable, that the family is identical with the Chalicotheriids which existed at nearly the same period in India as well as in Europe.

At an earlier epoch of the history of our continent (the Eocene) existed a still more characteristic type, which has been isolated by Professor Marsh as even a distinct order of Mammals, under the name of Dinocerata. The animals so distinguished were closely related to the Proboscideans (elephants, etc.), but of a much more generalized type; like them, they had columnar legs and pentadactyle feet, but the articulations of the tarsals and carpals severally with each other and with the proximal segments of the limbs were quite different. These animals, like the *Brontotheriidæ*, were also distinguished by their formidable armature; some of them, at least, are believed to have had as many as three pairs of horns—two frontal, two supraorbital, and two nasal. They were moreover provided with very large and trenchant or sabre-like canines; the incisors were rudimentary, or entirely obsolete; the molar teeth were very small; the brain was still smaller than in the *Brontotherium*, although the animals were in some cases at least as large as elephants. All the certainly known representatives of this group have been found in the Eocene beds of Wyoming.

During the same epoch in North America lived another peculiar type, and which has also been distinguished as a special order of mammals by Professor Marsh under the name *Tillodontia*.

These forms have quite a characteristic combination of characters: the skull of the known species has superficial resemblance to that of a bear; the incisor teeth were much like those of rodents, being two in number in each jaw, and apparently reproduced by gradual growth from their bases; the molars resembled those of the pachyderm ungulates; the feet were pentadactyle; the scaphoid and lunar were separate from each other; the digits provided with claws. This unusual combination of characters can not be reconciled with the accepted diagnostic marks of any of the existing orders; and either the generally admitted definitions or the orders of the present age will have to be modified to include these extinct forms, or the forms thus left must remain, as indicated by Professor Marsh, as representatives of a distinct order. The brain, as in the *Dinocerata*, was very small in comparison to the bulk of the animal, although (as might have been premised from the size of the animal) much larger in proportion than in the latter. The species known were smaller animals than those of the group just noticed, the best known species of *Tillotherium* being only about half or two thirds the size of the common South American tapir.

In the same Eocene period, and perhaps contemporary with the last, lived a horse-like animal of a still more generalized type than any of those which had previously been made known. This animal was about as large as a fox, but somewhat more robust in its proportions; the feet had well-developed digits—four in front; behind, three perfect, and a fourth ("fifth") rudimentary metatarsal; the radius and ulna in the fore limb, and the tibia and fibula in the hind, were distinct and well developed. The type so distinguished has been named *Eohippus* by Marsh, and two species have been recognized: it belonged, apparently, to the family of *Orohippidæ*, and probably was the nearest relative to the progenitors from which have descended the modern equine mammals.

Contemporary with these, and identifying their geological horizon, was an animal whose remains have been identified both by Marsh and Cope with the genus *Coryphodon*, long known by imperfect fragments from the Lower Eocene beds of Europe. The more perfect remains found in this country prove that the animal was a generalized perissodactyle ungulate of peculiar family, with five digits, and not at all nearly related to the living Tapirids or the allied Lophiodontids, as has been generally supposed.

The mammals of the Eocene are the earliest of the higher types of the class that have yet been discovered: between them and those of the Trias a great blank intervenes, representing an enormous period, and deposits of vast thickness, which have yielded up to the present time no certainly identified remains of mammals, although, of course, they must have been living during the whole of that epoch. The conditions of life were very favorable, however, for the development of reptile life, and representatives of that class were the monarchs of the time.

The Cretaceous epoch in this country, as in Europe, was distinguished by the great development of certain peculiar reptiles. Among these the most characteristic and strange in many respects were the *Pterodactyles*, or Flying Lizards. Not long ago these were supposed by some not to have lived in America, but now quite a number of forms have been discovered in this country. Among these were some distinguished from the forms previously known from Europe by the absence of teeth, and with this condition were co-ordinated other characters: these animals have, therefore, been distinguished under the name *Pteranodon*, and even presented as the representatives of a suborder (*Pteranodontia*) distinct from other pterosaurians, which, as tooth-bearing animals, must then be contrasted under the name "Pterodontia."

From certain strata of the Territory of Montana, whose age has been disputed, Professor Cope, in a recent expedition to that region, has obtained numerous species of reptiles, especially of the order of Dinosaurians. Some of these were of large size, and among them were apparently carnivorous as well as herbivorous species.

In a still earlier age of the secondary epoch, in widely separated parts of the world, a remarkable group of reptiles existed, which were characterized, according to Owen, by teeth resembling those of typical mammals, in that they had "incisors defined by position, and divided from the molars by a large laniariform canine on each side of both upper and lower jaws, and the lower canine crossing in front of the upper, as in mammalia." The earliest described remains of any representatives of the group were made known, but without appreciation of their systematic relations, by Russian naturalists, and were found in certain deposits in Russia that have been referred to the Permian age. In 1876 Professor Owen further elucidated the affinities of the group, and described a considerable number of species from rocks of South Africa which have been assigned to the Triassic epoch. These have been grouped into two sections or families—Binarialia, characterized by the external nostrils being divided by a narrow partition, and Mononarialia, distinguished by the external nostrils being single and undivided. To this group of Theriodontia has also been referred a form, described by Professor Leidy, from Prince Edward's Island.

BOTANY.

BY W. G. FARLOW, M.D.,
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Although the present year has not been marked by any brilliant discovery in vegetable morphology or physiology, it has been productive in descriptive works, and in experiments which have proved valuable as confirming what was known or previously suspected, rather than as tending to revolutionize previous ideas.

DESCRIPTIVE BOTANY.

Among the descriptive works bearing more directly on the flora of the United States must be mentioned the first volume of the "Botany of California," published by the geological survey of that state, aided by contributions from private sources. This volume includes the *Polypetalæ* by Professor W. H. Brewer and Mr. Sereno Watson, and the *Gamopetalæ* by Professor Asa Gray. The volume, except that it is without illustrations, resembles in form the "Botany of the Clarence King Expedition," by Mr. Watson. Another contribution to the botany of the western country is the "Flora of Southwestern Colorado," by T. S. Brandegee, reprinted from Hayden's "Bulletin of the Geological and Geographical Survey of the Territories," Vol. II., No. 3. To this pamphlet Professor Asa Gray and Dr. Engelmann have contributed. In the "Proceedings of the American Academy of Arts and Sciences," January 5th, 1876, is a paper by Professor Gray, in which he describes a number of new American species, and gives a synopsis of American *Mimuli*. In the "Transactions of the Academy of Science of St. Louis" Dr. George Engelmann has published two valuable papers. The first, "Notes on Agave," December, 1875, but reprinted at a later date, contains a description of species of that genus, thirteen of which occur in the United States. The second article is a revision of the "Oaks of the United States." A series of plates of American flowering plants, by Isaac Sprague, with descriptions by Professor G. L. Goodale, is announced to appear at the close of the year. Descriptions of new American *Musci* and *Hepaticæ*, by C. F. Austin, have been published in the Bulletin of the Torrey Club; and new species of American fungi have been described by J. B. Ellis, Charles H. Peck, W. R. Gerard, Rev. M. J. Berkeley, M. C. Cooke, and Baron Von Thümen, in the Bulletin of the Torrey Club and Grevillea. New species of American Algæ have been described by Professor J. E. Areschoug in the *Botaniska Notiser*.

The two most important works on the phanerogams of foreign countries have been the second volume of the "Genera Plantarum," by Bentham and Hooker, which contains the genera of *Gamopetalæ*, and the second volume of the "Flora of British India," by Dr. J. D. Hooker. In French there has been a monograph of the *Pomeæ* by Decaisne, and continuations of the *Primitiæ Monographiæ Rosarum* by Crépin. In addition, there have been numerous less important contributions to our knowledge of different genera and orders which we can not particularize in the present connection.

The leading works on descriptive cryptogamy have been a third volume of the "Species, Genera, et Ordines Algarum," by Professor J. G. Agardh, of Lund, in which he gives a review of the *Florideæ*, but does not acknowledge the results of recent researches in arranging his classification; and "Notes Algologiques," by Gustave Thuret, edited by Dr. Edouard Bornet, the first fasciculus of which has appeared. The plates of the latter work deserve great commendation. Descriptions of new fungi and lichens are contained in numerous short papers scattered through the different journals. Among the more curious fungi are two genera, *Kalchbrennera* and *MacOwanites*, described by Berkeley in the *Journal of Botany*.

EXPEDITIONS.

During the present year a report on the botany of Kerguelen Island was made by Dr. J. E. Kidder in the Bulletin of the United States National Museum. The report showed interesting additions to the flora of that island, including phanerogams as well as cryptogams. The reports of different British botanists, Berkeley, Dickie, Eaton, and others, on the collections made by the British Transit Expedition, have been partially published in English journals, but have not as yet been collected into one volume.

VEGETABLE HISTOLOGY AND CELL STRUCTURE.

The structure of the cell has been discussed by Strassburger in "Ueber Zellbildung und Zelltheilung." A reply to Strassburger was made by Professor Auerbach in an article entitled "Zelle und Zellkern," published in Cohn's *Beiträge zur Biologie der Pflanzen*. Auerbach maintained that the cell nucleus consists of a fluid which in time surrounds itself with a wall, and which later contains a number of nucleoli. Strassburger in his work attacks this view of the nature of the nucleus, and says that "Auerbach has, at any rate, considered the vacuoles which form in the nuclei as the nuclei themselves." Auerbach rather acrimoniously replies to this, and the contest seems to be one relating rather to the use of certain technical terms than to a matter of fact. In Pringsheim's *Jahrbücher* Tschitstiakoff has published an article on the structure of the cell.

In the *Annales des Sciences* have appeared a second memoir by

Professor Duchartre, entitled "Observations sur les Bulbes des Lis," and a "Mémoire sur l'Anatomie de l'Écorce," by Julien Vesque, in which the structure of the bark is considered at considerable length, without, however, adding much to our knowledge in the way of newly discovered facts. In the *Botanische Zeitung* Bolle has given an account of the "Terminal Growth of the Angiospermous Root-cap," and Dr. Reuther an account of the "Development of the Flower." In the same journal Graf Solms-Laubach describes the development of the flowers of *Brugmansia Zippelii*, Bl., and *Aristolochia Clematitis*, L. In Pringsheim's *Jahrbücher* Reinke treats of the organs of "Secretion of Leaves," especially those found on the teeth.

INSECTIVOROUS PLANTS.

Since the appearance of Darwin's book on this subject, several observers, among whom is Professor Rees, have published results confirming Darwin's experiments with regard to *Drosera*, and Mr. Francis Darwin has published (*Quarterly Journal of Microscopical Science*, July, 1876) some details of the process to which his father applied the name of aggregation, in *Drosera rotundifolia*. With reference to the digestive powers of *Dionæa*, Dr. Fraustadt has made a careful study of the anatomy of its vegetative organs. The attention of botanists has more especially been turned of late to the digestive power of the *Sarraceniæ*, or pitcher-plants, concerning which an article appeared in *Harper's Magazine* from the pen of Mrs. Mary Treat. Mr. Burgess reported at a meeting of the Natural History Society in Boston that he had found that the lip of the leaf of *Sarracenia purpurea* secreted sugar. M. Casimir de Candolle, in a paper in the *Geneva Archives des Sciences Physiques et Naturelles*, doubts whether the animal matter caught by the leaves of *Dionæa* is utilized by them.

VEGETABLE PHYSIOLOGY.

Mr. Francis Darwin read before the Linnæan Society of London a paper on the "Hygroscopic Mechanism by which certain Seeds are enabled to bury themselves in the ground." The hygroscopic twisting of the awn on certain seeds he considers owing to the power of torsion in the individual cells. Professor Asa Gray, in the *Naturalist*, gives an account of some peculiar qualities of certain Borraginaceous seeds. The "Influence of Light on the Color of Flowers" has been the subject of some experiments by Askenasy, who comes to the conclusion that in the majority of cases of plants grown in the dark the flowers are of the normal color. In the *Botanische Zeitung* Reinke has a long article on the growth of plants. In a later number of that journal Sachs complains that Reinke's method is borrowed directly from that pursued at Würzburg.

CRYPTOGAMY; HIGHER CRYPTOGAMS.

During the year the attention of botanists has been more particularly drawn to the *Hepaticæ* than to any other portion of the higher cryptogams. Prantl and Leitgeb have frequently discussed the subject in the journals and society meetings, but have not published articles of any length. In ferns, the development of the prothallus of the *Cyatheæ* has been studied by Dr. Bauke. Dr. Stahl, of Strasburg, describes the production of protonemata from the sporogonium of mosses.

LICHENS.

In a morphological point of view, very little has been done with this group during the year. The discussion of the Schwendener theory, which for the last few years has been very animated, has somewhat subsided. Winter has made contributions to the knowledge of the crustaceous lichens in the case of the genus *Sphæromphale.*

FUNGI.

In this department great activity has prevailed, both in the descriptions of new species, which have been limited principally to pamphlet articles, and in investigations with regard to the development of the different orders. The absorbing topic has been the fertilization, by means of a carpogone, of certain species of *Coprinus,* which was supposed to be the key to the development of all the *Hymenomycetes.* In 1874 Rees announced the discovery of a carpogone in *Coprinus,* and was soon confirmed by Van Tieghem, of Paris, in the *Comptes-Rendus,* February, 1875. A short time afterward, however, Van Tieghem reported in the *Comptes-Rendus* that he had been wrong in supposing that what he considered the *spermatia* were the male organs, as he had found subsequently that they germinated, and were consequently a form of stylospores. During the present year the discussion has been continued by Rees, Brefeld, and Van Tieghem in the *Botanische Zeitung* and *Comptes-Rendus;* and Van Tieghem and Brefeld both now believe that what was supposed to be a carpogone in *Coprinus* has nothing to do with sexual reproduction. Van Tieghem goes farther, and hints that the so-called reproduction by a carpogone is, in most of the *Ascomycetes,* an entirely asexual process, judging by his observations on *Chætomium,* which are not yet published in full. Brefeld denies the existence of any group of *Carposporeæ* as described by Sachs, founding his statement on the fact that in a new species of *Mortierella,* which belongs undoubtedly to the *Zygomycetes,* a carposporic fruit is developed. In the *Annales des Sciences,* Cornu gives in detail his "Observations on the Germination of Spermatia," which he thinks can not be considered male organs. Dr. Hermann Bauke has studied the development of certain pycnidia, and finds, as Tulasne has already suggested, that they are simply conditions of species of *Pyrenomycetes.*

VEGETABLE PATHOLOGY.

In the Bulletin of the Bussey Institution are articles on the effects of *Fumago salicina* on orange and lemon trees in California, on the disease of grape-vines in America caused by *Peronospora viticola*, and on the "black knot" of plum and cherry trees. Mr. Charles H. Peck, in the Proceedings of the Albany Institute, has a paper on diseases of the Black Spruce. The potato-rot fungus was the subject of a communication made by Professor De Bary, of Strasburg, to the Royal Agricultural Society of Great Britain. He calls in question the statements of Worthington G. Smith that he had discovered the oöspores of *Peronospora infestans*, the fungus causing the rot, but thinks that the so-called oöspores may belong to a new species of *Pythium*, which he calls *Pythium vexans.* De Bary makes *Peronospora infestans* the type of a new genus, which he calls *Phytophthora.* On the other hand, Mr. Smith replies by an article in the *Gardener's Chronicle* that he has watched the germination of the oöspores, and finds that they reproduce the *Peronospora.* The question can hardly be settled satisfactorily until some competent person shall confirm the views expressed by one side or the other.

ALGÆ.

In the *Botanische Zeitung* Cienkowski describes the palmelloid state of a species of *Stigeoclonium.* Reinke, in Pringsheim's *Jahrbücher*, and Rostafinsky describe the apical growth of the *Fucaceæ*, finding that some genera, as *Sargassum*, have a single terminal cell, while other genera, as *Fucus*, do not. Sachs, in *Floru*, has some curious observations on the forms which zoöspores assume in water, which he ascribes to the mechanical action of currents rather than to a vital movement. In the *Beiträge zur Biologie* Cohn has some remarks on the organization of zoöspores.

BACTERIA.

Of the almost numberless articles on *Bacteria* which have appeared during the year, those by Bastian are almost the only ones in which the theory of spontaneous generation is still maintained. By far the majority of writers believe that bacteria as well as all other plants come from previously existing germs, and the object on the part of the botanists has been to trace the development of some one species. This has to a certain extent been done by Cohn in an article in the *Beiträge zur Biologie der Pflanzen*, in which he gives an account of the formation of spores of *Bacillus subtilis.* Cohn maintains that he has proved that the bacterial form which appears in fluids which have been boiled is not *Bacterium Termo*, but always a *Bacillus*, to which he gives the name of *Bacillus subtilis.* *Bacterium*

Termo loses its germinating power by boiling, while *Bacillus subtilis* does not. Dr. Koch, in the *Beiträge zur Biologie*, also gives an account of the discovery of spores in *Bacillus anthracis*, a bacterial form found in inflammation of the spleen. Among the more interesting species of bacteria studied during the year is *Bacterium rubescens*, formerly considered an alga, and called *Cryptococcus roseus*. Attention was first called to this species in the *Quarterly Journal of Microscopical Science* by Professor Lankaster, and more recently Cohn has written on the subject. These two writers do not agree as to the presence of cilia in certain conditions of this species. Observers of bacteria have often been troubled by the admixture of different species in the same fluid. To obviate this difficulty, Dr. Salowonsen, of Copenhagen, places his nourishing fluid in capillary tubes. If different species are produced they will appear in different parts of the tube, which can be broken at any desired point and a drop of fluid obtained.

DISTRIBUTION AND VARIATION OF PLANTS.

In an interesting article in the *Annales des Sciences*, M. Charles Contejean shows the important influence which the chemical nature of the soil exercises on plants. He finds that plants may be divided into well-marked groups, according as they are affected by different chemical ingredients of the soil. He distinguishes two floras—a maritime, including plants which require salt, and terrestrial, which can not endure a soil containing salt. The terrestrial flora is divided into calcicoles, or plants requiring a calcareous soil; calcifuges, which avoid it; and indifferent plants, which are neutral toward it. Each of these four divisions is subdivided into xerophiles, plants preferring dryness, and hygrophiles, preferring a damp soil. M. Naudin, in an article on disordered variation of hybrid plants, mentions the case of a hybrid of *Lactuca virosa*, and a variety of the common lettuce. This hybrid did not show any tendency to vary, and M. Naudin maintains that a hybrid is nothing but a sort of living mosaic; each portion of which is reclaimed by the parent species.

NECROLOGY.

Leopold Fuckel died at Vienna, May 8th, while returning from a journey to Italy. He was for many years an apothecary at Oestrich, on the Rhine, and is known for his mycological writings, and his published collection of fungi, entitled "Fungi Rhenani."

Adolphe Brongniart died at Paris, February 18th. He was born January 11th, 1801, and in 1834 was chosen member of the Academy. He was the first fossil botanist of his time, and was employed upon an extensive work on fossil plants at the time of his death.

AGRICULTURE AND RURAL ECONOMY.

By Prof. W. O. ATWATER.

EXPERIMENT STATIONS.

European Agricultural Experiment Stations.—By far the largest part of the investigations made at present in agricultural science comes from the agricultural experiment stations. These institutions are indigenous in Germany. The first one was founded in Moeckern, in Saxony, in 1852. Since that time scarcely a year has passed without seeing new stations founded in Germany or other parts of Europe. In 1875 there were, as appears from statements in the *Landwirthschaftlichen Versuchs-Stationen*, the organ of the German stations, some 40 in the German Empire, of which Prussia had 21, Saxony 6, Bavaria 4, Baden 2, and Würtemberg, Saxe-Weimar, Mecklenburg-Schwerin, Hesse-Darmstadt, Brunswick, Anhalt, and Alsace-Lorraine 1 each. Of the other European countries, the Austrio-Hungarian Empire had 6, Italy 12, France and Switzerland 2, and Russia, Belgium, and Holland 1 institution each, which could be technically called experiment stations. Besides these sixty-five experiment stations, there were some twenty-five laboratories and other establishments, supported by agricultural schools, societies, or private individuals, and occupied with researches in agricultural science.

It is not easy to determine exactly the number of experiment stations in active operation in Europe at the date of the present writing—the close of 1876. That the number has increased very considerably during the year is evident from data gathered from a number of European agricultural and scientific journals and reports of stations, which make the number essentially as follows: German Empire, 50; Austrio-Hungarian Empire, 7; Belgium, France, Switzerland, and Russia, 2 each; Italy, 13; and Holland, 1—making 79 in all, besides nearly thirty laboratories not technically experiment stations, but whose work is, entirely or in part, the same as that of the stations proper. Some of the latter class are very well supported and efficient. Among these may be mentioned the following:

"The private laboratory and farm of Boussingault, at Bechelbronn, near Strasburg, in Alsatia, dating back, as a source of most valuable agricultural investigations, to the year 1835."

"The private laboratory and experimental grounds of John Bennet Lawes, Rothamstead, England, where, with the co-operation of Dr. J. H. Gilbert, a vast number of admirable field and stall experiments have been carried on since 1845, at an annual cost of some $15,000.

The laboratory and experimental grounds, with an endowment fund of £100,000 sterling, have been placed in trust by Mr. Lawes, to remain forever devoted to the investigation of agricultural science."

The laboratory of the Royal Agricultural Society of England, under the direction of Dr. Voelcker, at London. Dr. Voelcker receives £300 sterling salary, £200 for investigations, and fees for analyses, which number some 700 annually. This work has been going on for over twenty years.

Each one of the larger universities and agricultural academies of Germany has, among its institutions for scientific research, one or more laboratories devoted to investigations in agricultural science. In these some of the most noted of the German investigators are employed. Twelve universities and three higher agricultural schools in Russia make similar though, at present, less generous provision for agricultural research.

It was only a very brief time after Italy was freed from papal rule, and united under the liberal government of Victor Emanuel, that steps were taken toward the promotion of its most important material interests by the establishment of agricultural experiment stations on the German plan. Some thirteen are now in operation there.

Among the means adopted by the German government for pacifying and improving the condition of the province of Alsace-Lorraine, lately acquired from France, were the establishment of a university at Strasburg and an experiment station at Rufach.

Experiment Stations in the United States.—The Bussey Institution of Harvard University, though not an experiment station in name, continues to show itself, under the direction of Professor Storer, a very efficient and useful one in fact. The first volume of its Bulletin—a work of some 470 large and closely printed pages—has been completed during the past year, and gives accounts of a large amount of work, as scientific and thorough as it is unostentatious.

The last report of the Connecticut Board of Agriculture contains a "Preliminary Report" of a part of the first year's work of the Connecticut Agricultural Experiment Station, which shows that this, the first institution of the sort in this country, is commencing what promises to be a successful career. Its chief attention thus far has been given to the subject of commercial fertilizers, though investigations of more abstract questions in agricultural science are in progress.

The example of Connecticut seems to bid fair to be followed in a number of the other states of the Union. The Vermont State Board of Agriculture, with the aid of Professor Seeley, of Middlebury College, who is secretary and chemist of the Board, have undertaken the establishment of an experiment station, of which the first Bulletin has already appeared. Prominent agriculturists in a number of other states have been urging before their respective legislatures the importance of appropriations for the same purpose.

FERTILIZERS AND FERTILIZER CONTROL SYSTEMS.

Experiment Stations and the Trade in Commercial Fertilizers.—It is just about twenty-five years since in Germany, as here, the trade in superphosphates, guano, and similar commercial fertilizers, began. The same stupendous frauds by adulteration and dilution of good things were practiced there as they have been, and we have great reason to fear still are, carried on here. But the experiment station has perfectly cured and rooted out these evils in all the districts where it has been established and appreciated. The experiment station there is prepared to furnish the farmers at small cost with an analysis of any fertilizer he proposes to buy. The farmers avail themselves of this aid. They will buy no fertilizer without an exact statement of its composition, and they buy with the understanding that any deficiencies in the stipulated amount of fertilizing matters shall be made good or deducted from the payment. Under such circumstances manufacturers can sell nothing that is not substantially what it claims to be. A further result of this system is that low-grade fertilizers are little sought, and those makers who can supply the best article, of uniform quality and at the lowest rates, have the business. With large sales the dealers prosper, while the consumers are satisfied with their purchases; and, instead of trying to see how they can get along with small use of purchased fertilizers, they are studying how to use the greatest quantities to advantage. The fertilizer market in Saxony and Prussia, where the experiment station has the universal sanction and confidence of the farmers, is just as settled and satisfactory as any branch of trade, and the farmers there buy superphosphate, guano, potash salts, etc., with as much security of fair dealing as we can feel in the purchase of sugar or nails.—*Professor S. W. Johnson, in Tenth Annual Report of the Sheffield Scientific School of Yale College.*

The German Fertilizer Control System.—The plans adopted by the German experiment stations for supervising the trade in fertilizers, though somewhat various in their details, have one fundamental characteristic in common, namely, an arrangement made between the stations and dealers, whereby the latter guarantee their goods to contain certain percentages of valuable ingredients, the verification of the guarantee being left to the analysis made at the stations. Provisions are at the same time made whereby purchasers can have samples of the articles they buy analyzed at small cost or for nothing, and thus assure themselves that their purchases are as represented. In many cases the chemists of the station select samples for analysis from stocks under their supervision. The farmers have thus the fullest security that they will get the worth of their money in the fertilizers they buy.

The Connecticut Experiment Station and the Fertilizer Trade.—A fertilizer control system on the German plan has been introduced in Connecticut by the State Experiment Station, and is working very satisfactorily. A considerable number of low-grade and fraudulent fertilizers have been examined, and their character exposed. One article, for instance, which had been sold for $55 per ton, a discount from the regular price of $60 per ton being made to "introduce the article," proved to be nearly one half sand, and to have a commercial value of about $8 per ton. Several parties who had bought and tried the article, on learning the result of the analysis refused payment, a considerable sum of money being thus saved to the victims of the fraud. Arrangements are made whereby responsible dealers sell their goods under supervision of the station, guaranteeing their composition, and holding them at all times subject to examination by the station. Purchasers have also the privilege of having the fertilizers they buy analyzed at the station at small cost or for nothing. In no case thus far has any article sold under the supervision proved essentially inferior to the representations upon which it was sold. Taking both composition and price into account, the fertilizers sold under the supervision of the station have cost the farmers on the average less than one half as much as those not so sold.

Report on Commercial Fertilizers at the Vienna Exposition.—The report on commercial fertilizers, by Professor P. Collier, member of the Scientific Commission of the United States to the International Exhibition at Vienna in 1873, has appeared in the form of a pamphlet of sixty-seven pages, and is replete with interesting matter. It gives a large number of statistics concerning the trade in fertilizers in Europe and America, their sources, character, value, and cost.

This report coincides fully with the common experience in Europe and in this country in showing that there is a great deal of fraud in commercial fertilizers; that the bulk of what is in the market is good, however; and that the only method to prevent frauds, enable the farmers to make sure of getting reliable wares, and at the same time to improve the general quality of the wares as sold, rests in control systems based on chemical analysis.

SEEDS, SEED CONTROL, ETC.

Investigations of Seeds in Germany.—Of the many new ways in which science has of late come to be applied to agriculture, one of the most interesting as well as most useful is in the investigation of seeds. In 1869 Dr. Nobbe, director of the agricultural experiment station at Tharand, in Saxony, commenced the study of seeds in common use in Germany, and founded the first "seed-control station." How much of good has come from this may be inferred from the fact that during the seven years that have since elapsed over 4000 samples of seeds have been examined at Tharand; that adulterations have been discovered, most ingenious in character, harmful in effect, and remarkable in amount, so much so as to work a by no means inconsiderable injury to the agriculture of the country; and that some twenty seed-control stations have been established in Germany, while others have been either founded or projected in Denmark, Austria, Hungary, Holland, Belgium, and Italy.

One of the outgrowths of Professor Nobbe's work at Tharand is his lately completed "Handbuch der Samenkunde," a volume of 642 pages, of which 390 pages are devoted to the physiology of seeds, 140 pages to the methods of determining their agricultural value, and the rest to the means of preventing frauds and other cognate topics. Some of the material of this work had been previously published in the *Landwirthschaftlichen Versuchs-Stationen*, and other German journals of agricultural science, and had indicated, what the completed work decidedly shows, that a really new science, most interesting in itself and useful in its applications, is being developed by Dr. Nobbe's researches. Aside from the valuable contributions thus made to our knowledge of the constitution and characters of seeds, and the nature and conditions of the germinative process, Dr. Nobbe has shown how different seeds may be readily distinguished from each other, how adulterations may be detected and their extent estimated, and has devised a simple and ingenious apparatus by the use of which may be determined what percentage of a given sample of seed is alive, and capable of germinating and producing vigorous plants.—*Nobbe, Handbuch der Samenkunde, Berlin*, 1876.

Adulterations of Seeds.—Some facts in this connection are cited by Professor S. W. Johnson, as follows: "It is but a very few years since attention was directed in Great Britain to the wholesale distribution of purposely adulterated seeds throughout that country, and stringent laws and severe penalties were there enacted to protect the farmer.

"There lately flourished in London establishments where the business of 'doctoring' turnip seed was prosecuted on an extensive scale. Old and worthless seeds, or the seeds of inferior kinds of turnips, were killed and colored, and used to the estimated amount of 20,000 bushels annually for adulterating the seed of those varieties most sought for by farmers. In London and on the Continent hundreds of tons of the cheap yellow clover seed (*Medicago lupulina*) were and still are mixed in larger or smaller proportions with the red clover seed, and sold at the high price of the latter.

"In 1868 three tons of so-called red clover seed were sold to farmers in the Saxon city of Chemnitz alone, of which two thirds was yellow clover. In Saxony light and inferior kinds of oats are extensively bought by seedsmen to adulterate the heavy and prized sorts.

The celebrated 'Probstei rye' is annually produced to the extent of 2800 to 3400 bushels; but the amount ostensibly disposed of in the seed trade is hundreds of thousands of bushels.

"Dr. Nobbe, director of the Tharand Experiment Station, reports finding in a sample of tall meadow fescue grass (*Festicu elatior*) 70 per cent. of adulteration; and two samples of so-called 'grass seed,' having all the external appearance of a good article, were found to consist of grass flowers only, without a ripe seed of any sort.

"The climax of this kind of ingenious villainy appears to have been reached in Hamburg, where there recently existed a manufactory of counterfeit clover seed, which was made from quartz sand, and with such skill as to deceive experienced judges, who have pronounced samples containing 25 per cent. of these quartz grains to be pure red clover seed.

"In a sample of Timothy seed which had the appearance of being very pure, Dr. Nobbe found about 7 per cent. of foreign seeds, in which he identified thirty-one different kinds, mostly weeds and inferior grasses; and he calculated that upon a Saxon acre (= 1.37 English acres) no less than 1,700,000 of these foreign seeds would be sown, or twenty-four upon every square foot, by using the customary quantity of this pure Timothy seed.

"Dr. Nobbe's experiments show that very many genuine commercial seeds are of inferior quality, yielding much less than the proper average of plants, probably from admixture with the fresh stock of old seed whose vitality is impaired or destroyed.

"The many complaints that are made of the poor quality of the seeds sent out by the Agricultural Department at Washington are in large degree explained by these revelations of the state of the trade in Europe.

"It is but six or seven years since Dr. Nobbe first called public attention to this subject. He has begun the publication of a book containing full descriptions and figures of all the useful and hurtful seeds that occur in commerce; and already at some twenty experiment stations farmers are able to get trustworthy examinations of seeds as to purity and vitality, and at a trifling cost."

NUTRITION OF DOMESTIC ANIMALS.

Experiments on the Feeding of Domestic Animals.—The agricultural science of the present day includes, as one of its most important branches, the investigation of the laws of the nutrition of domestic animals. Under this general subject the special one of the digestibility of fodder materials has during the last eighteen, and especially during the last ten years been studied by feeding-trials with horses, oxen, cows, sheep, goats, and swine. These digestion experiments have been made almost exclusively at the German agricultural experiment stations, where over one thousand, each occupying the labor of several men for days, weeks, or even months, have already been executed, and others are continually in progress. That so enormous an amount of work should have been accomplished is explained by the fact that thirteen of the German stations, each employing from two to five chemists, are engaged in researches in animal nutrition.

Some lately reported feeding-trials with sheep, by Schulze and Märcker at the station at Weende, in Hanover, are of interest as confirming the very important deductions from previous experiments of the same class. It has been found that a certain portion of the woody fibre of plant food is digestible and nutritious, from forty to nearly seventy per cent. of the fibre in hay, clover, and straw being digested by cattle and sheep, and a smaller proportion by horses. This crude fibre consists of cellulose (which has the same composition as starch) and other materials richer in carbon. It is believed that the cellulose constitutes the digestible part of the fibre. This view finds a remarkable confirmation in experiments referred to, in which the composition of the digested portion of the fibre coincided almost exactly with that of cellulose. Results identical with this have been found in numerous other experiments at Weende and elsewhere.—*Journal für Landwirthschaft*, 1875, s. 141.

Effect of Albuminoids and Carbohydrates upon Digestion.—It is a familiar fact that all ordinary fodder materials consist of water, mineral matters, and two classes of organic substances—the albuminoids (gluten, fibrin, etc.), which contain nitrogen, and the carbohydrates (sugar, starch, cellulose, etc.) and fats, which contain no nitrogen. One of the important principles brought out by the German experiments is that unless foods, especially mixed rations, contain a sufficient proportion of albuminoids, they are not economically digested. When carbohydrates, as sugar or starch, or materials rich in these, as potatoes, are fed in considerable quantities with hay and straw, less of the latter is digested than when they are fed alone. On the other hand, nitrogenous substances, as gluten and, likewise, foods rich in albuminoids, as oil-cake, cotton-seed meal, beans, pease, and bran, when fed even in considerable quantities with hay and straw, do not decrease the digestion. Thus, in the experiments of Schulze and Märcker, mentioned above, large quantities of gluten of wheat, and of bean-meal as well, caused no depression in the digestion of hay or aftermath, while the addition of starch and sugar to the ration decreased the digestion of the whole organic substance of the former by nine per cent., that of the albuminoids by fifteen per cent., and that of the crude fibre by eight per cent.

Lupines as Food for Sheep.—Quite in accordance with the above are the results of late experiments by Dr. Stohmann, director of the station at Leipsic, on lupines (seeds) as food for sheep. The lupines proved almost completely digestible, and (being highly nitrogenous) exerted a very favorable influence upon the digestion of the hay. From twenty to thirty-nine per cent. more of the crude fibre was digested from the hay fed with lupines than from the same hay when fed alone. To the bitter taste, which renders lupines unpalatable to cattle, sheep do not seem to object. As a rich food for fattening sheep, Dr. Stohmann says that lupines rightly used can hardly be too warmly recommended.—*Mittheilungen des landw. Institutes der Universität Leipsig, Berlin*, 1876.

Effect of Potatoes and Turnips on Digestion of Hay and other Coarse Foods.—It is well known that a large number of experiments have been made within the last few years in the German stations on the influence of potatoes and turnips upon the digestion of hay and other coarse foods with which they are fed. It has been found that concentrated foods which contain little albuminoids and considerable carbohydrates (starch, sugar, etc.) decrease the digestion of coarse foods, and that this is quite true of turnips, and still more true of potatoes. This fact is shown in a remarkably decisive manner by the results of over one hundred experiments with sheep, conducted by Wolff and others during the past few years at the experiment station at Hohenheim. Wolff concludes that, as other experiments have indicated, the decrease of digestion of hay is decided by the proportion of albuminoids to carbohydrates in the whole ration; while potatoes, turnips, and other foods rich in carbohydrates, mixed with hay, decrease the digestion of the latter. If nitrogenous materials be added, the effect of the carbohydrates is counteracted.—*Landwirthschaftliche Versuchs-Stationen*, 1876, XIX., s. 35.

Influence of Fats upon Digestion.—Dr. Wolff has reported some experiments upon the much-discussed subject of the influence of the fats and oils of food upon digestion. Four full-grown wethers were fed, in each of several experiments, with hay to which were added, in the individual trials, concentrated foods, in some cases nearly free from oils, and in others containing more or less fatty or oily substance. Bran meal, palm-oil cake, with varying quantities of oil, were the substances employed. Wolff concludes from these experiments that the fat in nitrogenous foods causes no alteration in the digestibility of the albuminoids, unless, as is apt to be the case when an excess of oily substance is fed, a disturbance of the digestion is thereby brought about. —*Landwirthschaftliche Versuchs-Stationen*, 1876, XIX., s. 49.

Influence of Salt upon Digestion.—Weiske and assistants have experimented upon the influence of salt upon the digestion of fodder by sheep. In the first of four periods, no salt; in the second, five grammes (about one sixth of an ounce) per head per day; in the third, ten grammes; and in the fourth, none was given with the food, the latter consisting of hay, straw, and barley. No essential variation in the digestion of either albuminoids, crude fibre, or other carbohydrates was observed in the different periods. The authors conclude that salt is without influence upon the digestion of these ingredients in the food. On the other hand, the digestion of the mineral substances increased with the addition of the salt.—*Journal für Landwirthschaft*, 1874, XXII., s. 371–396.

Influence of Shearing on Digestion in Sheep.—It is a matter of common experience that sheep fatten better after shearing than when carrying a full coat of wool. To test the question whether this is due to a better digestion of food has been the object of some experiments by Weiske and his assistants at Proskau, in Germany. The sheep experimented upon were found to digest no more of their food after shearing than before. They consumed much less water, however, when shorn, and excreted somewhat less in the excrement and urine, and very considerably less in respiration and perspiration. The appetite was also much improved, and to this the better results in the fattening of shorn sheep are probably due.—*Journal für Landwirthschaft*, 1875, XXIII., s. 306–316.

Influence of Arsenic on Digestion of Food by Sheep.—The above-mentioned experimenters have also reported results of experiments on the influence of small doses of arsenic upon the digestion of food by sheep. The feeding of twenty milligrammes (about one eighth gramme) of arsenious acid (white arsenic) per head daily increased both the digestion and the accumulation of flesh in slight degree.—*Journal für Landwirthschaft*, 1875, XXIII., s. 317–322.

Action of Cold upon Milk.—Professor Maurice Perkins, of Union College, translates for the *Country Gentleman*, from the Paris *Comptes-Rendus*, an abstract from a paper by Eug. Tisserand, which gives some statements that are of interest in connection with the discussions now going on here with regard to the Hardin and other systems of setting milk for cream.

Numerous experiments have been made by exposing milk to different temperatures varying from 32° Fahr. to 100° Fahr., and the following facts have been elicited:

1. The rise of the cream is the more rapid as the temperature to which the milk is exposed approaches 32°.

2. The volume of the cream is greater when the milk has been efficiently cooled.

3. The yield of the butter is also greater when the milk has been exposed to a very low temperature.

4. Finally, the skimmed milk, the butter and cheese, are of better quality when prepared under the above circumstances.

While it is impossible to offer a satisfactory explanation as to the reason why artificial cold should produce a beneficial effect upon the yield and quality of the products derived from milk, it is probable that it may tend to arrest that fermentative decomposition which is so prone to set in with organic fluids, and thus, by preventing incipient alteration, indirectly to improve the quality of the material.

The practice of warming the dairy in winter-time, so as to maintain its atmosphere at a constant temperature of about 60°, is therefore objectionable; the pans should stand in running water at as low a temperature as can be practically obtained.

It is further suggested that the foregoing facts should be brought prominently before the notice of those who are engaged in the manufacture of dairy products, in order that the many erroneous notions on this subject may be gradually eliminated.—*Country Gentleman, November* 23, 1875.

RELATIONS OF CONSTITUENTS OF SOIL AND AIR TO PLANT-GROWTH.

Rendering Mineral Phosphates Soluble by Composting and Treating with Chemicals.—Some interesting experiments on the effects of composting in rendering soluble the phosphoric acid of mineral phosphates have been made by Holdefleiss at the experiment station at Halle, Germany. Lahn phosphorite, containing 28.86 per cent. of phosphoric acid and 4.88 per cent. insoluble matters, was composted with peat, earth, urine, dung, salts of ammonia and of potash, separately and mixed in various ways. The general plan of the experiments consisted in mixing certain quantities of phosphorite with weighed portions of earth or horse-manure, putting the mixture in boxes, adding, in some cases, sulphate of ammonia, potash salts, or carbonate of lime, and keeping each moistened with either water or urine from the last of May until the fourth of the following January. The total dry substance, total phosphoric acid, and phosphoric acid soluble in citrate of ammonia, were determined in each case at the beginning and at the end of the experiment. Sixteen different mixtures, in as many boxes, were tested. In every case except one there was a slight increase of soluble phosphoric acid, but in none was this increase sufficient to be of practical moment.

In a previous series of similar experiments nearly fifty per cent. of the phosphoric acid of a phosphorite mixed with peat was rendered soluble. The explanation of this variation was found in the fact that the peat of the first trial contained sulphur, which by oxidation produced sulphuric acid, which in its turn rendered the phosphoric acid of the phosphate soluble.

From these very carefully conducted experiments it seems that there can be very little practical utility in the attempt to render mineral phosphates more available as fertilizers by composting. They would, of course, be still slower in becoming soluble when applied directly to the soil. These investigations coincide with general experience in indicating that mineral phosphates, however finely ground, can not be of much value except when treated with acid.

It would seem at first thought that the object might be attained by using peat rich in sulphur or sulphur compounds, as iron pyrites; but a result of the oxidation of iron sulphide would be the formation of protosulphate of iron, which would be injurious to vegetation.—*Zeitschrift des landwirthschaftlichen Central-Vereins der Provinz Sachsen*, 1876, I., s. 11.

Oxidation of Nitrogen in its Compounds in the Soil.—The experiments above described had a further and more important object. One of the most weighty questions which agricultural chemistry has yet to solve is that of the changes which nitrogenous compounds undergo in the soil. One part of the problem is the effect which various substances exert upon the oxidation of nitrogen in its compounds. To gain some new light on this subject, determinations were made of total nitrogen, nitric acid, and ammonia in each mixture at the beginning and at the end of the experiment. In general the nitrogen of the organic compounds evinced a very marked tendency to become oxidized to nitric acid, stronger than has been previously noticed, from one half to two thirds of the whole nitrogen being in some cases oxidized. The nitrification was directly proportional to the amount of carbonate of lime present. The nitrogen of the ammonia salts became oxidized with extreme slowness, but was still oxidized to some extent in presence of carbonate of lime. Potash salts prevented nitrification completely. It is suggested that the failure of ammonia salts as manures in soils poor in lime may be owing to the slow oxidation of the ammonia to nitric acid, and that the poor effects sometimes observed with potash salts may in some cases be due to their hindering the nitrification of nitrogenous organic materials in the soil.—*Zeitschrift des landw. Central-Vereins der Provinz Sachsen*, 1876, I., s. 14.

Nitrification Experiments by Boussingault.—Of interest in this connection are some experiments on the same subject lately reported by Boussingault, whose varied researches on the nitrogen of the atmosphere and soil in its relation to the nourishment of plants are already classic. The especial object of these last experiments was to test and compare the effects of sand and lime (as carbonate), each by itself, with that of a soil (loam), upon the formation of nitric acid from the nitrogen of organic substances of animal origin used as manure. Neither sand nor lime seemed by itself to favor especially the formation of nitric acid, while a "sandy-clayey" soil, with only 0.02 per cent. of lime, promoted the oxidation of nitrogen very decidedly.—*Comptes-Rendus*, 1876, LXXXII., 477–479.

At first sight, the results of Boussingault's experiments would seem to be quite at variance with those of Holdefleiss, and with the common belief that lime in soils favors nitrification; but it will be observed that Boussingault's results refer to lime when used alone, as carbonate of lime, while Holdefleiss worked with soils containing lime, that is, under circumstances which approach more nearly to those which actually exist in cultivated soils.

The Assimilation of Atmospheric Nitrogen and the Absorption of Ammonia by the Soil.—The much-vexed question as to whether the soil has the power of assimilating free nitrogen is still in dispute. Simon and Dehérain claim to have proved the absorption of free nitrogen by organic compounds; but Boussingault, in a long-continued experiment, found a loss rather than gain of nitrogen in the soil, and Schloessing, on repeating Dehérain's experiments, fails to find any such absorption of nitrogen as the latter investigator reported. Schloessing has made several series of experiments on the absorption of ammonia by soils. In one series he passed air over a trough containing three hectoliters of soil, determining the amount of ammonia in the air before and after contact with the soil. There was a considerable loss of ammonia, indicating that some had been absorbed.

In two other series of experiments small portions of soil were exposed to the action of the air. In each parallel trials were made, the soil in one being in open air and kept moist, while that in the other was covered and dry. In all cases ammonia was absorbed, and in part oxidized to nitric acid. The oxidation was, however, much greater in the moist than in the dry soil. These experiments, therefore, confirm the generally accepted view that soils absorb ammonia from the air and transform it into nitric acid.—*Comptes-Rendus*, LXXXII., 1105–1108, 1202–1204.

Absorption of Free Nitrogen of the Air by Organic Compounds.—Berthelot has shown that free nitrogen is absorbed by organic compounds at the ordinary temperature under the influence of the silent electrical discharge. Benzene, oil of turpentine, marsh gas, acetylene, and moistened filter-paper absorbed nitrogen, producing compounds all of which evolved ammonia on being heated either alone or with soda-lime. The author suggests that similar processes may take place in nature, and that consequently plants may be able to assimilate nitrogen directly from the air. This assumption is directly opposed to the results of the best investigation upon the subject, which indicate that the free nitrogen of the air is not assimilated by plants. It would seem more probable that the absorption of free nitrogen by humus, and by soils containing humus, which Simon and Truchot claim to have observed, might be induced in the manner described by Berthelot. The experiments named are certainly valuable contributions to the solution of the much-vexed question of the assimilation of free nitrogen.—*Comptes-Rendus*, LXXXII., 1283, 1284, 1357–1360; LXXXIII., 677–682.

Ash of Hemp and Buckwheat Plants.—A quite extended chemical examination of the ashes of the hemp and buckwheat plants is reported by Dr. Peters, chemist to the Geological Survey of Kentucky. Analyses are given of five samples of the whole hemp plant, of samples of leaves, stems, and roots separately, of the dew-rotted plants, and of hemp fibre and hemp herds. Two samples of buckwheat plants were analyzed. The results, with some practical conclusions which the author feels warranted in making, are given in a pamphlet of twenty-five pages, taken from a report of the Geological Survey. The analyses make a valuable addition to our knowledge of the composition of these plants. Only the analyses of the ash are given, however, no mention being made of the nitrogen, an omission which, if supplied, would add very materially to the completeness and value of the work. — *Geological Survey of Kentucky*, Part III., Vol. II., Second Series.

INDUSTRIAL STATISTICS.

By WILLIAM H. WAHL.

IRON AND STEEL.

The same remarks with which we introduced our *résumé* of the condition of the *Iron* producing and manufacturing industries of the country in last year's *Record* will apply with equal force to our present statement. These were, in brief, that, though presenting certain favorable features, the condition of these industries was much the same as at the close of the previous year. An inspection of the accompanying statistical tables will afford the reader an oversight of this field of industry, brought down to as recent a date as the returns at our command will permit.

From the annual report of the secretary of the association, it is announced that the production of pig-iron in 1875 was 2,266,581 net tons, against 2,689,418 tons in 1874, 2,868,278 tons in 1873, and 2,854,558 tons in 1872. A comparison of these figures shows a decrease of production in 1875, as compared with that of 1874, of 422,832 tons, or more than 15 per cent. The actual production of 1875, as ascertained, is somewhat larger than our estimate published in last year's *Record*. Of the total pig-iron product of 1875, 908,046 tons were anthracite, 947,545 tons were bituminous coal and coke, and 410,990 tons were charcoal iron.

The number of completed furnace stacks at the close of 1875, not including abandoned stacks, was 713, against 693 at the close of 1874, and 657 at the close of 1873. During the year 1875, therefore, 20 stacks were added to the productive capacity of the country. Of these 713 furnaces, at the close of 1875, 293 were in blast, and 420 were out of blast.

Of the total production for 1875, it appears, on further analysis, Pennsylvania made 42.4 per cent.; Ohio, 18.3; New York, 11.7; Michigan, 5; New Jersey, 2.8; Wisconsin, 2.7; Missouri, 2.6; Illinois, 2.2; Kentucky, 2.1; and the remaining iron-making states each less than 2 per cent.

The following table shows the production of pig-iron (of all kinds) for the years 1872, 1873, 1874, and 1875, arranged by states, based upon statistics collected from the manufacturers by the American Iron and Steel Association:

States.	Whole No. completed Stacks, Dec. 31, 1873.	Whole No. completed Stacks, Dec. 31, 1874.	Whole No. completed Stacks, Dec. 31, 1875.	No. of Stacks in Blast, Dec. 31, 1875.	No. of Stacks out of Blast, Dec. 31, 1875.	Make of Pig-iron in 1872. Net Tons.	Make of Pig-iron in 1873. Net Tons.	Make of Pig-iron in 1874. Net Tons.	Make of Pig-iron in 1875. Net Tons.
Maine........	1	1	1	1	..	....	780	1,661	2,046
Vermont......	2	2	2	..	2	2,000	3,100	3,450	2,400
Mass.........	6	6	6	4	2	17,070	21,136	27,991	21,255
Connecticut..	10	10	10	5	5	22,700	26,977	14,518	10,880
New York....	53	58	57	26	31	291,155	296,818	326,721	266,431
New Jersey..	16	17	18	6	12	103,858	102,341	90,150	64,069
Pennsylvania	262	266	278	118	160	1,401,497	1,389,573	1,213,133	960,884
Maryland....	22	23	24	7	17	68,031	55,986	54,556	38,741
Virginia.....	35	33	34	8	26	21,445	26,475	29,451	29,985
N. Carolina..	8	8	8	..	8	1,073	1,432	1,340	800
Georgia......	8	10	12	5	7	2,945	7,501	9,786	16,508
Alabama.....	11	14	14	6	8	12,512	22,283	32,863	25,108
Texas........	1	1	1	..	1	619	280	1,012	....
W. Virginia..	6	9	12	4	8	20,796	23,056	30,184	25,277
Kentucky....	25	27	23	8	15	67,396	69,889	61,227	48,339
Tennessee...	20	22	22	7	15	42,454	43,134	48,770	28,311
Ohio.........	88	93	100	54	46	399,743	406,029	425,001	415,893
Indiana......	8	8	9	4	5	39,221	32,486	13,732	22,081
Illinois......	10	10	12	3	9	78,627	55,796	37,946	49,762
Michigan....	33	34	34	14	20	100,222	123,506	136,662	114,805
Wisconsin...	13	14	14	6	8	65,036	74,148	50,792	62,139
Missouri.....	18	19	19	6	13	101,158	85,552	75,817	59,717
Oregon......	1	1	1	1	..	....	....	2,500	1,000
Utah.........	..	1	1	..	1	....	....	200	150
Minnesota...	..	1	1	..	1	....	....	....	....
Total......	657	698	718	293	420	2,854,558	2,868,278	2,689,418	2,266,581

A recapitulation of the foregoing statistics, showing the relative proportions of the various kinds of pig-iron, and the magnitude of the several branches of the industry, is given below:

Kinds of Pig-iron.	Whole No. completed Stacks, Dec. 31, 1873.	Whole No. completed Stacks, Dec. 31, 1874.	Whole No. completed Stacks, Dec. 31, 1875.	No. of Stacks in Blast, Dec. 31, 1875.	No. of Stacks out of Blast, Dec. 31, 1875.	Make of Pig-iron in 1872. Net Tons.	Make of Pig-iron in 1873. Net Tons.	Make of Pig-iron in 1874. Net Tons.	Make of Pig-iron in 1785. Net Tons.
Anthracite...	207	217	225	100	125	1,369,812	1,312,754	1,202,144	908,046
Charcoal....	279	295	281	95	186	500,587	577,620	576,557	410,990
Bituminous Coal and Coke	171	181	207	98	109	984,159	977,904	910,712	947,545
Total....	657	693	713	293	420	2,854,558	2,868,278	2,689,418	2,266,581

The New York *Iron Age* has published a valuable statistical report, showing in detail the condition of the blast furnaces of the country on September 1st, 1876, which enables us to draw the inference that the production of the year just past will show a considerable decrease as compared with 1875. The journal in question affirms that the reports it publishes are nearly complete. One of the notable facts shown by the report is that a much larger proportion of furnaces are out of blast than at corresponding dates of 1874 and 1875. The following table shows comparatively the results of reports made to the journal referred to during the last three years:

Fuel.	In Blast.			Out of Blast.		
	1874.	1875.	1876.	1874.	1875.	1876.
Charcoal..........	143	109	70	63	161	152
Anthracite........	122	86	70	65	121	155
Bituminous.......	83	89	76	98	107	133

Percentage in and out of blast of whole number reporting:

Fuel.	In Blast.			Out of Blast.		
	1874.	1875.	1876.	1874.	1875.	1876.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Charcoal..........	69	40	32	31	60	68
Anthracite........	61	42	31	39	58	69
Bituminous.......	46	45	36	54	55	64

The following gives a comprehensive summary of the condition of things:

FUEL.	Total No. of completed Stacks.	No. of Stacks Reporting.	No. of Stacks in Blast.	Weekly Capacity, in Gross Tons, of the Stacks in Blast.	No. of Stacks out of Blast.	Weekly Capacity, in Gross Tons, of the Stacks out of Blast.
Charcoal............	285	222	70	6,797	152	12,009
Anthracite...........	225	225	70	13,790	155	28,605
Bituminous	209	209	76	18,675	133	27,065
Total............	719	656	216	39,262	440	67,679

Following the published statistics of the association, we are enabled to affirm that the total production of rolled iron in 1875 was 1,890,379 net tons, against 1,839,560 tons in 1874, and 1,966,445 tons in 1873. These figures embrace all kinds of rails, including Bessemer cut nails and spikes, bar, band, hoop, plate, sheet, angle, girder, beam, boat, guide, rod and bridge iron, and rolled axles, and are exclusive of forged iron, such as anchors, anvils, hammered axles, cranks, ships' knees, etc.

The total production of iron and steel rails of all sizes in 1875 was 792,512 net tons, against 729,413 tons in 1874, 890,077 in 1873, and 1,000,000 in 1872. Of this total for 1875, 501,649 tons were iron rails (against 584,469 tons in 1874), and 290,863 tons were Bessemer steel rails (against 144,944 tons in 1874). The increase in the production of Bessemer rails during the year 1875 was therefore more than 100 per cent. over the production of 1874. The increase in the quantity of street rails produced was also noteworthy, the product of 1875 being 16,340 tons, as compared with 6,739 tons in 1874.

There were during the year 1875 ten completed Bessemer establishments in this country in more or less active operation. Two of these, the Edgar Thompson and the Lackawanna, were started in that year, as noticed in our last year's *Record*. During the year 1876 one new establishment, the Vulcan, at St. Louis, which made its first blow in the month of July, was added to the list, making the total number of Bessemer works in the country eleven. The following table of Bessemer rail production, drawn from the association's statistics, completes our annual *résumé* of this important branch of the iron industry up to January 1st, 1876:

	Net Tons.		Net Tons.
1867 (ascertained)............	2,550	1872 (ascertained)...........	94,070
1868 "	7,225	1873 "	129,015
1869 "	9,650	1874 "	144,944
1870 "	34,000	1875 "	290,863
1871 "	38,250		

As will be observed, by the inspection of our last year's comments, the secretary's estimate for 1875 was somewhat below the mark. The use of Bessemer steel for general purposes is rapidly increasing. The total quantity of pig-iron (including spiegeleisen) converted by the pneumatic process in 1875 was 395,956 net tons, as compared with 204,352 tons in 1874, and 183,534 tons in 1873. Not less than one sixth of our total production of pig-iron in 1875 was converted into Bessemer steel; and so active is this industry that a notable increase may be expected for the year 1876. Some 33,245 tons of spiegeleisen were used in the Bessemer establishments of the country in 1875, of which 7832 tons were produced in the United States. No new spiegeleisen furnaces went into operation during the year 1876.

The details of the domestic Bessemer industry appear in the following tabular statement:

	1874.	1875.
Tons of pig-iron and spiegel converted.......	204,352	395,956
Tons of ingots produced.....................	191,933	375,517
Tons of rails produced......................	144,944	290,863

Great Britain's product of Bessemer steel ingots during the year 1875 was 592,000 tons, as compared with 540,000 tons in 1874. An inspection of the table of domestic production given above will show that the rate of increase in this country is far greater than in Great Britain.

The aggregate product of the fifty-four establishments in this country making steel other than Bessemer was for the year 1875 61,058 net tons, as compared with 49,681 tons for 1874. Of this total, 39,401 tons were crucible steel, and 21,657 tons were puddled, blister, and open-hearth steel. The association publishes the following table, showing the production of steel (other than Bessemer) by states during the year 1875 in net tons:

STATES.	Crucible Steel.	Puddled, Open-hearth, and Blister Steel.	Total.
New England	1,620	4,510	6,130
New York	2,300	....	2,300
New Jersey	7,098	160	7,258
Pennsylvania	26,615	11,520	38,135
Maryland and Georgia	268	1,500	1,768
Ohio	1,300	3,667	4,967
Kentucky and Illinois	200	300	500
Total	39,401	21,657	61,058

The production of open-hearth, or Siemens-Martin steel, as noted in our last year's report, shows a steady increase, the production for 1875 being 9050 tons, as compared with 7000 tons in 1874, 3500 in 1873, and 3000 in 1872. The secretary of the association reports that the product of 1875 was made by twelve establishments.

The accompanying memorandum of the Siemens furnaces built and in course of construction during the year 1876 to date of writing is given on the authority of Dr. Siemens' American agents, Messrs. Richmond & Potts:

Iron and steel melting-furnaces of various capacities, from 15 to 50 tons in 24 hours	39	furnaces.
Open-hearth steel-melting for the manufacture of homogeneous iron or steel upon the open hearth	4	"
Double puddling-furnaces	12	"
Crucible-steel melting-furnaces of 54 pots' capacity	2	"
Spiegel melting-furnaces for the manufacture of spiegel	2	"
Total	59	"

The same authority places the product of the forges and bloomaries in the country in 1875 at 49,243 tons, as compared with 61,670 tons in 1874.

The following, then, are the leading facts in connection with the number, capacity, and character of the iron and steel establishments of the country, as gleaned from the association's tables, bringing the record up to January 1st, 1876:

Whole number of blast furnaces, excluding abandoned furnaces, January 1st, 1876	713
Annual capacity of all the 713 furnaces, in net tons	5,439,230
Whole number of rolling-mills, January 1st, 1876	332
Whole number of single puddling-furnaces (double furnaces counting as two)	4,475
Total annual capacity of all rolling-mills in finished iron, net tons	4,189,760
Annual capacity of all the rail-mills in heavy rails, net tons	1,940,300
Number of Bessemer steel-works, January 1st, 1876	11
Annual capacity in ingots, net tons	500,000
Number of Bessemer converters	24
Number of open-hearth steel-works, January 1st, 1876	22
Annual capacity in ingots, net tons	45,000

Number of crucible, German, blister, and puddled steel-works, January 1st, 1876	39
Annual capacity of merchantable steel, net tons	108,250
Of which there were of crucible steel, in net tons	45,000
Number of forges making blooms direct from the ore, January 1st, 1876	39
Annual capacity in blooms and billets, net tons	59,450
Number of bloomaries, January 1st, 1876, making blooms from pig-iron	59
Annual capacity in blooms, net tons	60,200

We add, in conclusion, the following table, presenting a summary of the production of the various branches of the iron and steel industries of the country, completing the similar table in our last year's *Record* up to January 1st, 1876 :

Products.	1873.	1874.	1875.
	Net Tons.	Net Tons.	Net Tons.
Pig-iron	2,868,278	2,689,413	2,266,581
All-rolled-iron, including rails	1,966,445	1,839,560	1,890,379
All-rolled-iron, excluding rails	1,076,368	1,110,174	1,097,867
Rails of all kinds	890,077	729,418	792,512
Bessemer steel rails	129,015	144,944	290,863
Iron and all other rails	761,062	584,469	501,649
Steel rails, included in iron rails	9,430	6,739	16,340
Kegs of cut nails and spikes	4,024,704	4,912,180	4,726,881
Merchantable Bessemer steel other than rails	27,985	31,635	84,654
Total Bessemer steel	157,000	176,579	375,517
Crucible cast steel	32,786	34,128	39,401
Open-hearth steel	3,500	7,000	9,050
All other steel	13,714	6,858	12,607
Blooms from ore and pig-iron	62,564	61,070	49,243

The total imports into the United States of iron and steel and manufactures thereof, during the fiscal year ending June 30th, 1876, were valued at $13,191,618; and the total domestic exports of these commodities for the same period at $15,175,166. The exports have therefore exceeded the imports by $1,983,548. In the list of imports of these commodities the largest items of decrease are those of rails of iron and steel.

Mr. Rothwell, editor of the *Engineering and Mining Journal*, states that the total production of anthracite coal in the United States for the year 1875 was 20,654,509 gross tons. That of bituminous coal the same authority places at 26,858,726 gross tons. The figures for the year 1876 are not yet available. The production of mineral coal in Great Britain during the year 1875, as obtained from the reports of the inspectors of mines for that year, was 149,303,263 net tons.*

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* The secretary of the association estimates the pig-iron production for 1876 to have been 2,050,000 net tons; and Mr. Rothwell estimates the production of coal of all kinds in the United States during 1876 to have been 45,500,000 gross tons.

From the most authentic sources of information at our command, we are enabled to make the statement that, from the date of the first discovery of gold in California down to the close of the year 1875, the total amount of gold and silver produced in the United States was as follows:

	Troy Ounces.	Value.
Gold	66,680,000	$1,332,700,000
Silver	201,300,000	261,450,000
Total	267,980,000	$1,594,150,000

It may not be out of place to interpolate here the following figures, prepared by Prof. R. W. Raymond, showing the production of the leading metals, minerals, etc., during the first century of the Republic:

Coal, anthracite (tons of 2240 lbs.)	341,521,423
Pig-iron " " "	40,000,000
Lead " " "	855,000
Copper " " "	200,000
Quicksilver, in flasks of 76½ lbs	840,000
Petroleum, bbls. of 42 gallons	76,594,600

From the published statements of the Chief of the Bureau of Statistics we present the following details, showing the quantities and values of articles imported into and exported from the United States during the fiscal year ending June 30th, 1876:

MERCHANDISE.

Exports, domestic (gold value)	$525,582,247
Exports, foreign "	14,802,424
	$540,384,671
Imports	460,741,190
Excess of exports over imports	$79,643,481

SPECIE AND BULLION.

Exports	$56,506,302
Imports	15,936,681
Excess of exports over imports	$40,569,621

A comparison of these figures with those of the year immediately preceding shows that we exported thirty millions less specie and bullion in the last than in the preceding year; and that our exports of merchandise exceeded our imports by nearly eighty millions, the balance of trade being more in our favor than for many years.

To supplement the above, we may append, in conclusion, the following facts concerning our internal commerce, as gleaned from Poor's *Railroad Manual* for 1876. It appears from this very reliable work that the tonnage of all the railroads in the United States during the past year was not less than 200,000,000 tons, having increased fortyfold during the past twenty-five years; at $50 per ton, the value would be $10,000,000,000. The canals of the country transported not less than 10,000,000 tons, worth $500,000,000. The tonnage of vessels employed in the domestic trade of the United States is 4,000,000; which, estimating four voyages per year and light freights, may be placed at 15,000,000 tons per annum, having a minimum value of $750,000,000. From the above there results the grand total of $11,250,000,000 per annum as the volume of the internal commerce of the United States—an amount nearly ten times as great as the value of our exports and imports combined.

INTERNATIONAL EXHIBITION OF 1876.

The Centennial Exhibition has passed into history, and although in a work of this nature it is obviously no part of our task to attempt the depiction of the magnificence and profusion of the works of human genius and ingenuity there displayed, and which have doubtless delighted the eyes and amazed and bewildered the understanding of most of our readers, we may properly devote a little space to a few comments upon its industrial results, relegating to our miscellaneous columns such descriptive items of the multitude of exhibits as appear to be worthy of special attention by reason of pre-eminent merit or novelty.

The most permanently valuable lesson of the Exhibition has doubtless been the ocular demonstration which it has afforded to multitudes of our own people of the prodigious strides made by the United States in every description of industrial enterprise, the direct and useful result of which will manifestly be the wide dissemination of the conviction, which there is every reason to hope may become the national belief, that in every branch of manufacturing industry that has reference to the general wants of the country the productions of the United States are fully equal and in many instances superior, by reason of better adaptation to domestic demands, than similar productions of foreign countries; and the American manufacturer will doubtless in the future be spared the humiliation of seeing the products of his mills and workshops sold as of French, English, or German make, to gratify the prejudice, now happily tolerably well dissipated, of that large body of our people in whose vocabulary the designation foreign was at once the synonym for and the assurance of excellence. Besides this quiet but complete revolution of opinion at home respecting the excellence of home productions, it was reserved for the Exhibition, by the institution of a direct comparison between the qualities of American and foreign wares beneath the eyes of consumers, to open new markets for them, to the permanent benefit of home manufactures. The far-reaching influence of this great educator of our people has been well expressed in the following terms by one of the leading daily journals: "Related to these varied ramifications of influence, the

Centennial Exhibition means a more rapid and comprehensive development of our material resources, a steady expansion of the activities of commerce and trade, a reign of unexampled prosperity, and the realization of industrial independence; the year 1876 possessing in this last respect the same relation which the year 1776 bore to our political independence."

Prior to the close of the Exhibition, steps were taken by enterprising gentlemen interested in such a project, to avail themselves of the admirable opportunity afforded by the existence of the vast collection of industrial and artistic treasures in the Exhibition buildings to secure the largest of them—the Main building—for the purpose of instituting therein a permanent exhibition. The project, at the time of this writing, promises to be most successful. The Main building has been secured for the purpose by purchase, and it is affirmed that applications for space on the part of intending exhibitors have already reached such a number that the managers will be obliged to make selections from the mass of materials offered for display. One of the attractive features of the permanent exhibition will be the presence of most of the handsome inclosures marking the exhibits of the various nationalities represented at the Exhibition—the most imposing and characteristic of which have been donated to the permanent exhibition by the proper authorities. The scheme for the establishment of a school of industrial art, and the creation of a museum for this purpose, in the Memorial Hall, likewise bids fair to be successfully accomplished; and last, but not least, we may record that, at the instance of the Franklin Institute, the authorities of the city of Philadelphia have given their consent to the retention of the Machinery Hall for the holding of periodical exhibitions of mechanical inventions under its auspices.

RAILROADS.

A new railway route between New York and Philadelphia, popularly called the "Bound Brook Route," was completed during the past year, and formally opened for traffic on May 1st. The following details of the new line may be found of interest. The route from New York follows the Central Railroad of New Jersey to Bound Brook; thence over the Delaware and Bound Brook Railroad, through the Hopewell Valley to Yardleyville, where it crosses the Delaware River by a substantial iron bridge; and thence over the North Pennsylvania Railroad to Philadelphia. At Bound Brook the line diverges from the main line of the Central Railroad of New Jersey, and, crossing the Raritan River, runs off southwesterly in an almost direct line to the Delaware River, a distance of twenty-seven miles. The iron bridge at Yardleyville, crossing the Delaware River and the Raritan Canal feeder, is 4000 feet in length, including approaches, and was built jointly by the North Pennsylvania and

Delaware and Bound Brook Railroad Companies. The new line is eighty-eight miles long, and is affirmed to be several miles shorter than other existing routes.

The success of the Boston, Revere Beach, and Lynn Railroad, it is reported, has started into life numerous schemes for narrow-gauge roads of gre[illegible]r or less length to radiate from Boston in all directions, the propositions being, in brief, to build a net-work of narrow-gauge railways from Boston to many of the principal towns between that city and Worcester and Fitchburg. The difficulty of entering Boston without cost it is proposed to meet by a pile bridge over the Charles River, and a tunnel under Beach Hill, coming out on Pemberton Square, or Washington Street, near the Old South Church. One of these proposed lines, the Newton and Boston, has already been surveyed through Brighton and Newton to East Natick. Another is the Boston, Watertown, and Waltham, with a branch to Cambridge. It is also proposed to finish the Massachusetts Central as a narrow gauge to West Boyleston. Another line is proposed from the west end of the tunnel and Charles River through Brighton, Newton, Wellesley, Natick, Framingham, Ashland, Southboro and Westboro to Worcester.

From foreign sources we glean the following outlines concerning the more important projects for railway extension, in course of execution or projected during the past year. In New South Wales the Colonial government has under consideration a proposition for borrowing £8,000,000 for an extension of the existing railway system, with particular reference to a project for connecting the port of Sidney with certain extensive coal-fields within a radius of fifty miles. Surveys have been made with the view to the establishment of a railway 360 miles long in Newfoundland, at a cost of £2,500,000. In Buenos Ayres an English company has projected a road from San Nicholas to Junon, to traverse about 100 miles of well-settled country. A contract for the construction of the Caraccas railway was concluded, and the road will probably be built with French capital.

On the continent of Europe it is declared that, in spite of the prolonged depression in trade, there is more activity and vitality in railroad circles than there has been for many years. At the close of the past year there were no less than 400 miles of railway in course of construction in Italy, and several new lines in contemplation. Some 400 miles of railway are about being constructed in Portugal, the necessary concessions and surveys having been made; while no less than eight new lines were authorized by the Austrian government, and a beginning was made with the Seville and Huelva Railway in Spain, 105 kilos. in length. A line was projected from Timbuctoo to Algiers by way of Galeah and the Sahara. The Russian government is said to have given serious consideration to the construction of a European-Siberian line from Kazan to Ekaterinburg, Yumen, and Artamovka. The official Russian geographer, in a report issued during the year, discussed various schemes for laying down roads in Siberia, and stated that none of these would be taken in hand before the completion of the European-Siberian line, 335 versts long. In France, about the close of the year, ten new lines were conceded to the South of France Railway Company, the cost of which is estimated at $17,000,000. In Belgium the government has had strong pressure brought to bear upon it, by leading iron manufacturers, to lay down new lines, and to purchase additional rolling stock for several years in advance, as a stimulus to the iron industries of the country; while in answer to similar petitions the German government decided upon the construction of several new lines. In England concessions were granted during the past year, by Parliament, for the construction of 705 miles of new railway, the estimated cost of which is given as £36,654,694. In India the construction of the important state lines, of which over 2000 miles remained to be completed at the close of 1875, was proceeded with energetically, and new railway projects for opening up that country, and bringing it into more direct communication with the mother country, were broached. Of this nature, for example, is the scheme for bringing Bombay within eight days of London by constructing a line from Scutari to Kurrachee, about 3300 miles, and another line from Antioch to Ismalia, a further distance—including branches to Damascus and Jerusalem—of 600 miles. The great Central Asian Railway, referred to in our last year's *Record*, was also revived, but nothing of special interest regarding it has transpired, save the conviction, which finds very general expression in well-informed circles, that the undertaking of this gigantic project will not be long deferred.

The present year has also witnessed the construction and opening of the first railway in China, which latter event occurred on the 30th of July. The line in question extends from Shanghai to Woosung, a distance of about ten miles. The concession for the same was obtained and the road was constructed by certain enterprising English merchants at a cost of some £30,000. It is a single line, with a gauge of two feet six inches, and is laid with a twenty-seven-pound rail of the Vignoles section on cross-sleepers. The occasion of the opening attracted a large concourse of native spectators, who evinced the liveliest interest in the proceedings. From all that can be learned of the present status of this first Chinese road, it appears to have become quite popular, and the most sanguine hopes are entertained by those interested in the opening up of the interior of the Celestial Empire by this pioneer of civilization that at last the decisive step toward the realization of their hopes has been taken.

The efficiency of the block-system of railway signals was admirably demonstrated by the scarcity of accidents on the Pennsylvania

Railroad during the progress of the Exhibition, when millions of passengers were carried over the road. This system is in operation on the New York division, and on the main line between Philadelphia and Pittsburgh. It consists, briefly described, in dividing a line of railway into sections or blocks, of such length that the movements of trains thereon can be easily controlled by telegraph operators stationed in signal-towers at the end of each block, who observe and record the movements of trains by telegraph, and who operate the signals by which the engine-drivers are directed. The apparatus of each station comprises a signal-box (rising about eighteen feet from the ground, and having sliding green and red signals, two on each side, of different colors), located near the track, so as to be easily seen by engineers of trains approaching from either direction, and the telegraphic apparatus within. By means of strong cords connecting the signals of each side with the working-room of the tower, the operator within can conveniently make the necessary changes in the signals.

The operation of the system is described as follows: Red is the stationary signal, and informs the engineer of an approaching train that he can not pass until a second signal shows that the block is clear. This information is conveyed by showing the white signal. A green signal is understood to mean that the engineer can proceed, but with caution, the block not being entirely clear of trains. The exact time at which each train reaches a station is telegraphed at once to the operators at the station just passed and the one next succeeding. The operator is thus enabled to notify the engineer of every train approaching a signal-tower with certainty of the condition of the track between the given point and the station next succeeding. The order conveyed by the danger signal is imperative, and no engineer dares to disobey it. Furthermore, no passenger train is allowed to pass a station while another train of the same class is on the block, or between the two stations, without a special order from the superintendent. Freight trains are allowed to run on a block in quick succession from two to five minutes behind each other.

TECHNOLOGY.

Mr. John E. Wootten described at one of the late meetings of the American Philosophical Society a combination of apparatus by which ordinary anthracite coal-waste, from the dirt-banks at the mines, can be profitably burned in the furnaces of stationary and locomotive boilers. The essential features of this device are described to be as follows: A closed ash-pan is provided, into which air is injected by means of a steam-jet passing through one or more tubes. Where volume of air rather than intensity is demanded, these tubes should be cylindrical; but when greater intensity is needed, as in the case of locomotives, they should be formed of two frusta of cones, united at their smaller diameters. The mingled air and vapors pass through a perforated fire-bed into the fuel which is spread over it to the depth of about three inches. The fuel upon the grate is gently lifted by the blast from over the perforations, the finer particles floating upon the current until entirely consumed, a large proportion of the ash passing off with the draft out of the stack. To insure the rapid and complete combustion of the fuel, and prevent the formation of solid masses of clinkers, it is recommended to stir it repeatedly upon the fire-bed with a rabble-shaped instrument. This stirring process, it is declared, is an important element in the use of the fuel under consideration, inasmuch as it serves to relieve the fire from the finely divided ash, which is thus exposed to, and carried by, the draft over the bridge-wall, or through the flues of the boiler into the stack. Another important element in the system is the perforated fire-bed, the perforations in the plate being from three eighths to three fourths of an inch in diameter, and from two to three inches from centre to centre. Wrought iron is preferred as the material of the fire-bed; and its peculiar construction reduces the loss of fuel through the grate during the stirring process to a minimum, the average loss being declared to be less than two per cent. of other coal put into the furnace. A locomotive engine using coal-dirt exclusively for fuel has for some time been engaged in hauling coal trains over the Philadelphia and Reading Railroad, generating steam freely without the use of any portion of the exhaust steam as a draught-promoting agent, the substitute being a continuous supply of air and vapor, introduced into a closed ash-pit, like that described above, aided by very small jets of live steam in the chimney for the purpose of facilitating the escape of the products of combustion. The results, Mr. Wootten claims, obtained from many boilers now using the apparatus before described, show that the hitherto neglected and apparently valueless material known as coal-dirt can be profitably used for generating steam, and that hereafter it must be regarded as a fuel of great value.

While but little progress appears to have been made toward the solution of the practical difficulties of mechanical puddling during the past year, we may mention that the experiment of ore reduction in Bessemer practice appears to have been successfully accomplished at the Cruzot Works, under the direction of M. Ruduer. From the results obtained by this metallurgist the following statements and recommendations are announced: The introduction of one half ton of pure ore into a charge of seven tons of iron, toward the end of the blow, gave, in M. Ruduer's experimental trials, an excellent quality of steel, with a clear slag containing scarcely any iron. He suggests as a better method that the iron ore be packed about the sides of the converter as fettling, and the same sintered somewhat together by a small charge of coke before running in the iron. One ton of ore to six or seven of iron may be used. The advantages claimed are: (1) Increased cheapness of the steel; (2) increased purity of the steel; (3) saving in time and fuel; (4) the possibility of using an iron poor in silica. The ore used should, however, not contain over 0.07 per cent. of phosphorus.

A process for utilizing waste iron, such as stove and machinery scrap, and the harder numbers of pig-iron, has been introduced in practice by Mr. William Batty, and is sufficiently useful and novel to warrant special mention. The essential feature of the process appears to be to recarbonize the iron, which always loses carbon when being melted in the usual way in the cupola. To neutralize the decarbonizing effects of the blast, the inventor feeds into the blast-pipe, just before it enters the tuyeres, a stream of pulverized coal (the gas-carbon which lines the retorts in the manufacture of illuminating gas being selected on account of its purity). The result is claimed to be the production of a neutral flame, which, as it contains rather an excess of carbon, the iron becomes carbonized, and therefore softer after melting than before. When the iron to be melted is very much decarbonized, Mr. Batty employs as an auxiliary a bed of charcoal in the bottom of the furnace. The inventor claims by this process to be able to melt iron-waste of every description—old castings, tin clippings, tin roofs, etc.—and produce therefrom castings of any desired quality by modifying certain details of the operation and varying its duration. He claims also to have doubled the productive capacity of the cupola, while effecting at the same time a decided economy of fuel.

The International Committee appointed by the American Institute of Mining Engineers have made a report proposing a new nomenclature for iron and steel, which, if generally adopted, will do away with much of the ambiguity which now attaches to the use of the term "steel," in consequence of its application to the products of the Bessemer, the Siemens-Martin, and other processes, which products will not harden and temper. The committee remarks, in its preamble, "Although homogeneity due to fusion is usually recognized, and is by this committee recognized as the most definitive characteristic of both hard and soft steel, this quality may be equally well expressed in other terms, thus leaving the old term 'steel' to define the malleable compounds of iron which will harden and temper." The report concludes with a resolution recommending the adoption of the following nomenclature:

I. That all malleable compounds of iron, with its ordinary ingredients, which are aggregated from pasty masses, or from piles, or from any forms of iron not in a fluid state, and which will not sensibly harden and temper, and which generally resemble what is called "wrought iron," shall be called WELD IRON (German, *Schweisseisen;* French, *fer soudé*).

II. That such compounds, when they will from any cause harden and temper, and which resemble what is now called "puddled steel," shall be called WELD STEEL (German, *Schweiss-stahl;* French, *acier soudé*).

III. That all compounds of iron, with its ordinary ingredients, which have been cast from a fluid state into malleable masses, and which will not sensibly harden by being quenched in water, while at red heat, shall be called INGOT IRON (German, *Fluss-eisen;* French, *fer fondu*).

IV. That all such compounds, when they will from any cause so harden, shall be called INGOT STEEL (German, *Fluss-stahl;* French, *acier fondu*).

The report is signed by the following distinguished metallurgists: I. Lowthian Bell, P. Tunner, A. L. Holly, Dr. Hermann Wedding, Richard Akerman, Thomas Egleston, and L. Gruner.

A new alloy, which promises to prove of considerable utility in the arts, has been brought out by Mr. P. M. Parsons under the name of manganese-bronze. The addition of manganese to bronzes, it is affirmed, deoxidizes the latter; its action being strikingly visible in the texture of the metal, the grain being fine and close, and the strength greatly increased. The new alloy may be forged at a red-heat, which increases its strength and toughness. Cast test-pieces have shown an ultimate strength of twenty-four tons per square inch; and, when forged, an ultimate resistance of 30.3 tons; elastic limit, twelve tons; elongation, 20.75 per cent. These figures indicate that the new alloy possesses an ultimate strength equal to that of good wrought iron, while greatly superior to the best gun-metal, for which sixteen tons and an elastic limit of seven tons are high strengths. The effects of forging in raising the strength of the alloy are very marked. It resembles aluminium-bronze in certain respects, but possesses a much superior resistance to this alloy, which does not exceed 22.6 tons, and is also inferior to manganese-bronze in elongation and elasticity. It is claimed that the new alloy will find an application wherever gun-metal is used, while the facility with which it may be forged, and the improvement resulting therefrom, will render it even more useful for constructive uses.

Among the Centennial Exhibits of materials especially applicable for railway purposes, one of the most interesting and important was the exhibit of a variety of articles of the alloy known as phosphor-bronze. When this material was first brought out some years ago, we presented in the *Record* some of the more important of the claims of its makers, and it is quite appropriate, now that it has attained in virtue of its peculiar properties a permanently valuable position in the arts, to give a *résumé* of the applications for which it has been ascertained to possess special value. The following statements, abridged from *Iron*, the leading English metallurgical journal, will be found to cover this subject quite fully, viz.: The superior endurance of this new alloy is bringing it rapidly into use for many other purposes besides those for which it was originally employed. It still continues in demand for bearings, but is being widely adopted with great advantage for pit-ropes, telegraph-wires, bolts, etc. When used for telegraphic purposes, it is claimed to have thrice the conductivity, and greater strength than the iron wire commonly employed. In its employment for bearings, it has been found to possess a power of endurance nearly five times greater than that of gun-metal, besides being less liable to heat. Even when heated, it is also affirmed, it does not cut the journals. In England and on the continent of Europe it has been largely introduced in the construction of the bearings of railway carriages that have to travel long distances without stopping. The gain in respect of economy is also great, showing a saving in favor of phosphor-bronze of four to one. The bearings of rolling-mill engines have to endure a similar amount of friction, and some of the largest concerns of this description in England have adopted it with satisfactory results.

Excellent results have also followed the use of phosphor-bronze for plungers, pump-cylinders, and piston-packing. When made into wire cables and ropes, it is affirmed not to be liable to take on a crystalline structure under the action of repeated shocks, which is the case with both iron and steel, as many fatal casualties testify. While it is very hard, it does not emit sparks when struck upon a harder surface, in virtue of which property it has been found to be very suitable for the tools used in the manufacture of gunpowder and the like. At the Centennial Exhibition the Phosphor-Bronze Company exhibited some fine ornamental castings, and specimens of bearings and other uses to which the metal is found applicable. The English government employs phosphor-bronze very largely in the royal arsenal gun and carriage departments. A number of the finest vessels of the English navy have likewise been fitted with phosphor-bronze bearings, slide-faces, bolts for propeller blades, slide and expansion valves, etc. Many of the Peninsular and Oriental steamships use it in their engine-fittings, and other steamship companies are adopting it for bearings, sheet-rings, slide valves and facings, piston-rod cross-head bearings, piston rings for high-pressure cylinders, etc. The authority from which we have gleaned the foregoing points concludes with the statement that a metal that can be made more ductile than copper, as tough as wrought iron, and as hard as steel, is necessarily fitted for many uses, especially as it can be remelted without any material loss or alteration in quality. In this country, finally, the use of the alloy is gradually extending.

It is worthy of note that while in this country we are just in the midst of a discussion of the feasibility of doing away with the objectionable system of carrying lines of telegraph on posts through the crowded streets of cities, and the substitution therefor of subterranean lines, the latter system has been in successful operation in the cities of Continental Europe and in England for the past twenty years. In many instances, for example, on the Continent, there are long lines of underground telegraph extending through the country, notably the lines connecting the German fortresses; and the cable laid directly on the surface of the ground in several cases suffices to insure permanent and reliable telegraphic communication between countries situated on opposite sides of the Alps and other mountains of Europe. *Apropos* of this topic, we note the appearance of a report that a subterranean line will be laid down between the cities of Halle and Berlin, and that in the future all the German telegraphs will be underground. The advantages of the underground or cable system as compared with the aerial are obvious. It obviates, to a large extent, the numerous causes of interruption of communication resulting from the breaking of wires, whether by accident or malice, accumulations of sleet, ice, etc., or the frequent falling of poles; it largely obviates the evil of the general imperfection of insulation, so severely felt by telegraph operators during a long spell of wet weather—to say nothing of the disfigurement of the streets and highways by posts and wires, which no amount of ingenuity can make sightly or attractive. That the unsightly pole system, with its many objectionable features, which have long since practically effected its banishment as a nuisance from the cities of Europe, should still be suffered to exist in this country, which of all others has contributed more than any other to improve the art of telegraphy through the achievements of a host of ingenious inventors, is one of the puzzles of the day, and affords a conspicuous example of indifference to the introduction of a demonstrated improvement that is eminently un-American.

In the province of illumination, perhaps the most noteworthy domestic event of the past year was the successful inauguration of the Lowe water-gas process at the Manayunk Station of the Philadelphia Gas Trust. In our *Record* of last year we gave a brief description of the *modus operandi* of this very interesting process, to which we must refer our readers for details, remarking only in this place that the gist of the process is the simultaneous decomposition of steam and petroleum in the presence of incandescent carbon (anthracite), in a vertical chamber termed the generator; the fixation of the resulting mixed gases by their passage through an intensely heated mass of fire-brick, in a second chamber called the superheater; and the subsequent washing and purification of the product according to the usual methods employed in the ordinary coal gas-works. The Utica works, which up to the present year were the largest that have been erected, and which were alluded to in our summary for the year 1875, had a daily capacity of about 200,000 cubic feet, and their actual production for a number of months, until the unfortunate destruction of the works by fire, was about 120,000 cubic feet daily, representing a total production during the eight months of their existence of about 21,000,000 cubic feet. These works were so remarkably successful as to have attracted the attention of gas engineers throughout the country. They demonstrated the adaptability of the Lowe system for the production of illuminating gas of high quality and permanence upon the largest scale, and secured for the system the distinction of being the first thoroughly practical solution of the "water-gas" problem, which a generation of inventors had been vainly striving to accomplish. The establishment of a Lowe plant at Manayunk during the last year, upon a much larger scale than had previously been attempted, has afforded those who are interested in this subject a most admirable opportunity of estimating the practicability of the system, and the results achieved have been, in every essential particular, all that the most ardent champions of the innovation could have desired. The two most striking features of the system, which attract the attention of the gas engineer, are the great compactness and simplicity of the plant, and the surprising rapidity with which gas of excellent illuminating power and permanency is produced. The following statements will give an idea of the results of its practical operation. The Lowe Establishment at Manayunk was erected during the summer of 1876, and went into operation on the 4th of August. The plant consists of three generators and six superheaters. The other portions of the plant consist of the usual washing and purifying devices of the common gas-works. The generators are 10 feet 6 inches high, and have an internal diameter of 40 inches. The superheaters are 15 feet high, with an internal diameter of 84 inches. Both generators and superheaters are very solidly constructed of fire-brick, and have double walls, leaving an intervening air-space. Generators, superheaters, condenser, scrubbers, and station-meter are contained within a building 27 by 57 feet.

The old coal gas-works, which the Lowe plant just described displaces, occupied with all their necessary appurtenances about an acre and a half of ground. The retort-house (109 feet long by 38½ feet wide) was furnished with ten benches of threes, and when worked continuously to their full capacity could produce about 5000 cubic feet of gas per hour—a quantity insufficient to supply the local requirement; in consequence of which the deficiency was supplied by pumping into the holder an additional supply from the works at Market Street, several miles away. The old works required the services of thirty-four men.

The new works occupy scarcely one tenth the space of the old (the essential portions of the plant being, as before remarked, contained in a building 27 by 57 feet). Until lately they have not been run up beyond one half their capacity, and have since the date of their going into operation been supplying, on an average, 150,000 cubic feet of 20-candle gas daily (a quantity quite sufficient to meet the local requirement), and employ the services of but seven men —three on the night shift, and four during the day. The cost of 20-candle gas delivered into the holder, inclusive of labor and interest on the investment, is admitted by the managers to be from 35 to 40 per cent. less than that of the coal gas of 16-candle power which the old works had been supplying; and this estimate will doubtless be still more favorable when the works are running up to their full capacity, and when the price of oil, which has of late been exceptionally high, returns to its normal market value. The capacity of the Manayunk plant is placed at 350,000 cubic feet daily, and the total production from August 4th to December 31st, 1876, has been 20,000,000 cubic feet. The progress that is being made in this direction will be best appreciated by the statement that during the past year the Lowe process has also been introduced at the Falls of Schuylkill and Stroudsburg, Pennsylvania, and at Clyde and Fort Plain, New York. At Kingston, Canada, Lowe works are at present in course of erection, and contracts have been effected for the building of works at the cities of Lancaster and Harrisburg, Pennsylvania; Trenton, New Jersey; Baltimore, Maryland; and Indianapolis, Indiana. The important bearing of this "water gas" system upon metallurgy and the domestic arts will appear in its proper place.

The introduction of the electric light into general use is likewise worth noticing. The experiment of applying it on shipboard appears to have been tried with satisfaction on the General Transatlantic Steamship Company's steamship *Amérique*, which has for some time been provided with one of Gramme's magneto-electric machines. The electrical signal light of the *Amérique*, when placed at the height of thirty-three feet above the water, is estimated to be visible for a distance of ten miles to an observer stationed twenty feet above the water. The advantages of the electric light are not confined, however, to lessening the risk of collision, but its powerful illuminating quality has been found extremely useful in loading and unloading, and in working the ship, and in guiding her in and out of port at night. By means of a cone of sheet-iron placed over the light, with the base of the cone uppermost, all the details of the ship's equipment are rendered visible for a considerable distance aside from the signal light. It is affirmed that the apparatus is inexpensive in operation, easily managed, and not liable to get out of order. The system of electric lighting has also, according to account, been successfully introduced at the depot of the Northern Railway in Paris, in several French industrial works, and in several Belgian coal-mines.

The use of chloride of calcium for watering the streets of large cities has been attended with considerable success, as appears from the following abstract of a presentation of the subject before the French Academy. This salt possesses, in addition to its eminent deliquescent properties, in virtue of which it absorbs moisture with the greatest avidity, and retains it, the advantage of being excellently adapted for this use by reason of its having little or no commercial value, so that in certain localities it is looked upon as a nuisance. During the past few years the principal streets of Rome have been watered with a solution of chloride of calcium, obtained from the numerous pyroligneous acid works in its vicinity. The result is reported to be that the dampness communicated to the road, instead of disappearing in a few hours, as would be the case when water alone was used, remains for a whole week, the road continuing damp without being muddy, and presenting a hard surface, on which neither wind nor passing pedestrians nor horses have any effect. In course of time, also, the road becomes covered with a sort of crust, which increases the durability of the surface. M. Houzeau, in discussing this subject before the Academy, estimated that the use of this solution showed a saving over that of water alone of over thirty per cent. The same savant likewise attributes to this method of watering the streets certain hygienic virtues which deserve consideration, to wit: The chloride of calcium obtained from the pyroligneous acid works always contains appreciable quantities of tarry matters and perchloride of iron, the dissemination of which in the atmosphere, it is affirmed, is most salutary; while, finally, the complete suppression of dust, which is attained by this simple but efficacious remedy, must needs exert a most beneficial effect upon public health.

Professor E. W. Dory has suggested a new and, it is affirmed, very sensitive test for alcohol, which, if it realize the claims made for it, may prove to be of much practical value. The reagent employed in this case consists of a solution of molybdic acid in strong sulphuric acid. When brought into contact with this solution, a deep azure-blue coloration is brought out, if alcohol is present. This test is affirmed to be so sensitive that a quantity of alcohol as minute as the one thousand six hundred and sixty-sixth part of a grain may readily be detected. Professor Dory, in commenting upon this reaction, points out the utility of his observation by reference to the frequent substitution of alcohol for chloroform in medical compounds and mixtures, and affirms that such adulteration, which may produce the most injurious effects upon the sick, may be at once detected by this process. Should this reaction be found to be what is claimed for it, it will prove of great value in general laboratory practice.

ENGINEERING IN GENERAL.

One of the noteworthy engineering events of the past year was the successful removal of Hallett's Point Reef, one of the most formidable obstructions to the navigation of New York harbor. In connection with this event, a brief summary of the operations undertaken by the national government for the improvement of New York harbor may be of interest. These operations, as gleaned from a trustworthy source, date from the year 1848, when Lieutenants Davis and Porter, U. S. N., made an examination of the narrow channel known as Hell Gate, leading from Long Island Sound to the East River. The narrow channel between Long Island and Ward's Island was rendered very dangerous by Hallett's Point Reef, that projected out into the river some three hundred feet, and caused the tide coming in from the Sound to be thrown over against an opposing rock known as the Gridiron. Besides these rocks, there were the Pot Rock, the Frying-Pan Rock, and Way's Reef, which were blasted as long ago as 1851–1852, by exploding cans of powder laid on their surface. From the above date nothing was done until the year 1866, when Major-General John Newton was assigned the duty of making an examination of the obstruction at this point, and of preparing plans and making estimates of the cost of the works necessary to remove them. The several plans submitted by this officer involved the removal of the reef at Hallett's Point, as a prominent feature, and in pursuance of these plans Congress made the first appropriation in 1869 for what have since been known as the Hell Gate improvements, assigning to General Newton the duty of carrying them out. From this time forward operations were carried on with more or less rapidity, and culminated, on the 24th of September, in the demolition of the reef by explosion. Without rehearsing details given in our last *Annual Record*, we may add the following tabular statement of the dimensions of the main headings, showing the extent of the submarine tunneling work:

HEADINGS.	Height of Opening at the Shaft.	Width of Opening at the Shaft.	Length of Tunnel.
	Feet.	Feet.	Feet.
No. 1	22	9	296
No. 2	21	10	186
No. 3	22	11	200
No. 4	22	11	195
No. 5	20	11	191
No. 6	19	9	124
No. 7	19	11	231
No. 8	19	12	214
No. 9	17	13	226
No. 10	13	10	300

The total length of headings was 4857 feet, and of the circular galleries or cross-cuts 2568 feet, making a total of 7425 feet. The amount of rock excavated was 47,461 cubic yards, and the cubic contents of the rock in the reef above the depth of 26 feet at mean low water amounted to 51,000 cubic yards. The rock itself was an extremely hard, foliated, hornblendic gneiss, intersected with numerous quartz veins, which rendered the progress of the tunneling work extremely difficult, and required the exercise of constant vigilance on the part of the engineers in charge of the work to avoid getting too near the bed of the river, and the shattering of the roof of rock by too heavy shots. In only one case, it is affirmed, was the roof endangered, and there a wall had to be built to support it. The explosives used in making the excavations were nitro-glycerine, several of its compounds, and common black powder. Since the year 1872 nearly all the drilling was done with the Burleigh rock-drills and the Rand drill. The diamond drill was used to some extent, principally for exploring the rock ahead of the work; but the varying hardness of the rocks and their inclination were unfavorable to it. Previous to 1872 the drilling was done by hand; and the progress of the work affords a good criterion by which to estimate the relative economy of hand and machine drilling. In this case the work of drilling was contracted for at so much per foot. Hand-drilling cost about 95 cents per foot, while the cost of drilling with the Burleigh rock-drills, including repairs, etc., was found to be, on an average, 36 to 37 cents per foot. The work of excavation was finished about the month of July, 1875, and the work of preparing for the final blast, involving the boring of holes in the pillars and roof, the charging of the same with explosives, etc., occupied a number of months. The firing of the mine was effected by electricity; and to effect the simultaneous explosion of all the holes, the conducting wires leading from the same were held on a cross-bar, forming a circuit closer; and the circuit was closed by firing a small torpedo which held the cross-bar up; when this took place, the bar fell, the brass points to which the wires were attached plunged into small cups filled with mercury, and which were connected with the second set of wires from the primers, and the circuit was closed. Every thing being in readiness, the water was let into the vast cavern, and on the afternoon of Sunday, the 24th of September, the mine was successfully exploded. The amount of disturbance caused by the explosion of the 52,206½ lbs. of dynamite, rend-rock, and Vulcan powder employed was moderate and circumscribed, and was quite a disappointment to a large body of spectators that had been attracted to the scene in the expectation of witnessing a terrific convulsion. As subsequent soundings demonstrated, however, the reef was very completely shattered, and the depth of the river considerably increased even before the removal of any of the *débris*, which eventually will all be dredged up. Until this is done the complete results of the work of demolition will not be accurately known. The work upon the Flood Rock excavations, it is understood, will now be energetically pushed forward, operations having been held in abeyance pending the consummation of the Hell Gate explosion.

During the year 1876 work upon the jetties at the South Pass of the Mississippi has been rapidly advanced, and, so far as may be inferred from what has already been accomplished, with every indication of ultimate success. The extent and location of the jetties are as follows: The lines of the jetties are 1000 feet apart. The length of the East Jetty, from the land's end to the deep water where the jetty-heads will be constructed, is about 12,500 feet. This extends out in nearly a straight line for 800 feet, and then curves to the west in order to strike more favorably the littoral current from the east which has been ascertained to exist. For most of its length this jetty is constructed on a lateral shoal where depths averaged not more than six or seven feet. At the other end it stops in thirty feet of water. The West Jetty, on account of the farther extension of the river-bank on that side, begins about 4000 feet farther down than the east one, and extends parallel to it out to the same point. At its beginning it was constructed in much deeper water than was the East Jetty, it being in fifteen feet of water, in what was the deepest channel of the bar at that point. This depth gradually shoaled to the crest of the bar, where it was from six to eight feet. The method of constructing the jetties has been fully described in our last year's *Record*, and need not, therefore, be here repeated. The improvements comprise, in addition to the building of the jetties, two other auxiliary works, namely, the closure of Grand Bayou and the construction of a dike at the head of the Pass. The purpose of these works is to deflect more water into the South Pass, and thus increase the velocity, and consequently the scouring action, of the current. Both of these auxiliary works, it is affirmed, have been completed. The following statement, given on the authority of D.W. Bowman, C.E., South Pass Jetty Works,* presents the condition of the jetties on the 26th of May last, since which time, although considerable progress has been made, no official statement of the actual condition of the work has come into our possession. This statement, although not as recent as could be desired, gives nevertheless a good idea of the rapidity with which the work under Captain Eads' superintendence is being pushed forward. At the date named the condition of the jetties was as follows: For a distance of about 11,500 feet from the land's end on East Bank the mattresses of both jetties were built up to average flood-tide, and confined nearly all the water. For about 500 feet farther the jetties were partially constructed, but did not reach the surface by several feet, the current flowing laterally over them. This work represents, at the expiration of eleven months from the commencement of operations, a total length of nearly 20,000 feet, or about four miles, exclusive of the work done at Grand Bayou and the head of the Pass. Mr. Bowman, commenting upon the results already attained, predicating his statements upon the work accomplished up to the above-named date, affirms that the action of the jetties has already been sufficient to judge of their final effect, and to enable those who have staked their professional reputations upon their success to vindicate the soundness of their conclusions. Careful soundings made on the 24th of March, 1876, and compared with the official survey made before the commencement of the work, showed that 1,815,000 cubic yards of the bar had, up to that time, been removed from between the jetties. The soundings at that time (May 26th) revealed the fact that there is a channel nowhere less than twenty-two feet in depth to within 2000 feet of the deep water of the Gulf. On this remaining distance the least channel depth was seventeen feet where the original crest of the bar had been, with only nine feet of water upon it. Not the least among the favorable results is the fact that, in the deep water in advance of the jetties, instead of any indication of a re-formation of the bar, as it was predicted by the opponents of the jetty system would occur, the soundings show that, by some cause or other, the depth of water has been increased. From all published accounts, therefore, it would appear that there is no reasonable doubt, from what has already been accomplished, of the ultimate success of the Eads' jetty experiment. At the time of this writing, for example, it is reported that the channel between the jetties at average flood-tide has every where a depth of not less than twenty feet for a width of 200 feet, and that in the centre of the channel there is a minimum depth of twenty-two and a half to twenty-three feet, and a maximum depth of thirty feet. In consideration of which facts the assertion is made that vessels are now certain of having a much wider channel across the bar than has ever been offered at the Southwest Pass, where for several years dredging operations have been carried on under government direction at an annual expense of several hundred thousand dollars.

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* See a complete *résumé* of this subject by this author in *Engineering News*, III., 180 *et seq.*

From an elaborate review of the present aspects of the Channel Tunnel project, which has lately appeared in the London *Standard*, we are enabled to glean the following facts bearing on the progress that has been made during the year just passed, viz.: The scheme in question, under Sir John Hawkshaw on the English side, and M. La Vallée on the French side, appeared more than a year ago to be making substantial progress. Three railway companies had announced their readiness to contribute their contingents of £20,000 each; and an English company had expressed its willingness to contribute the balance of the £80,000, which, according to Sir John Hawkshaw's estimates, were necessary for the trial works then in contemplation, and which were to have been at once proceeded with at St. Margaret's Bay, three or four miles to the east of Dover. The *Standard*, replying to the query as to the progress made by the English, affirms that it has amounted to less than nothing—retrogression. One of the parties interested has clung to the £80,000 trial works at Dover, involving a shaft nineteen feet in diameter, colossal pumping engines, and a submarine driftway seven feet square. Another party, in the railway interest, advocated the expenditure of a few thousands at a time for smaller trial works, to make a shaft seven or eight feet in diameter, less pumping power, and as moderate a driftway under the channel as could practically be driven. By this means, it was claimed, the requisite practical knowledge of the difficulties of the work in contemplation could be gained with the minimum of expenditure, the sum of £20,000 being named as the maximum amount for which such a shaft could be driven, and a suitable driftway carried under the sea for a distance of a third of a mile, and pumping machinery erected capable of pumping 500,000 gallons per day. The result of this conflict of opinion appears to have been that those who were depended upon to supply the funds needed for the preliminary works have either withdrawn their influence or have held aloof, and matters on the English side have, in consequence, remained practically at a dead lock.

On the French side, we are informed on the same authority, there has been a quiet and steady onward movement on a small but useful scale. The dredgings of Sir John Hawkshaw on that side of the channel were confirmed and enlarged by M. La Vallée and his staff some time ago. Since September of the year 1875 the English sea-bottom of the channel has been sounded, and additional confirmations and more precise knowledge obtained; and a boring was commenced and is just finished at Sangatte, about six or seven miles west of Calais. The official report of the French engineers upon these results has not yet appeared, but the following statements afford as complete a *résumé* thereof as can be made from extra-official sources of information. The boring was commenced at Sangatte, on the upper white chalk, at somewhat less than half its thickness; it has penetrated the lower white chalk, and has gone through about sixty-six meters of gray chalk, identical in all its distinguishing characteristics with the gray chalk on the English coast. It has further penetrated into the gault clay after passing a thin band of dark-green upper greensand; the total depth of the boring is 133 meters, and the diameter 24 centimeters. As one of the objects of these borings was to ascertain the amount of water that would be likely to be met with in the final operations, the shaft has been lined to a considerable depth with iron tubing of different diameters, let in telescopewise, the annular space between the tubes being filled in with cement, in order that the same might be consolidated and rendered water-tight. On this score the results obtained appear to have been quite favorable, the amount of infiltration being quite small, and derived, notwithstanding the proximity of the sea, from spring water only. The borings in question have demonstrated, quite independently of the shore sections, the character and thickness of the stratum through which it is proposed to pierce the tunnel; and, further, that, notwithstanding the fact that the thicknesses of the several strata all diminish toward the French coast, they are yet of sufficient magnitude for all the engineering requirements of the contemplated improvement.

All the knowledge gained by this means, however, although it may meet the most favorable expectations of the friends of the tunnel, neither proves nor disproves the hostile theories which have long existed, and which still exist as to the occurrence of a vertical fissure along the whole median line of the English Channel, and which discussion will only be settled when the driftways of the tunnel itself are actually driven from the shores of both countries, and are about to meet midway under the bottom of the sea.

It may be well to add, in conclusion of this subject, that, should the plan of directly driving a tunnel be found impracticable, there remain several other plans of connecting France and England: one by a colossal bridge; another by a subaqueous tube laid on the bed of the channel; and a third, consisting of a platform supported on wheels, which run on rails laid on a causeway of some thirty-three feet in height, and thirteen feet in width, raised on the comparatively level bed of the channel. On this causeway it is proposed to run a vehicle 380 feet in length, 125 feet high, and composed of a pontoon at the base, and a platform above the water, united by suitable framing. The platform is to be large enough to take on board an entire railway train; and the device is to be propelled by an engine located on the platform, which, by means of a chain-belt, operates a drum, over which winds a chain that lies upon the causeway. This plan is an extension of the ideas embodied in M. Leroyer's water railway, in successful operation at St. Malo, in France.

Concerning the project of an interoceanic canal across the American isthmus, of which we gave a somewhat detailed account in our *Record* of last year, it may be remarked that, although our government has taken no steps toward carrying out the views of the commission which recommended the Nicaragua route, the subject of the canal has attracted considerable attention abroad. It was announced, for example, at a late session of the Société de Géographie, that a considerable body of gentlemen had obtained a concession from the Colombian government for the building of an interoceanic canal across the Darien Isthmus. A scientific commission, it was affirmed, would start in November to make a thorough survey of the proposed line between the Gulfs of Uboba and St. Miguel. It is furthermore affirmed that the Colombian government, at the instigation of M. Gogorza, has authorized the survey of a route by way of the Rivers Atrato and Tuyra, which promises to be superior to any hitherto explored route.

The active interest which this subject is attracting abroad is well indicated by the fact that the Société de Géographie of Paris has established during the past year a French section of a proposed "International Committee to study the question of cutting a canal through the American isthmus," which section has entered into relations with all the geographical societies in the world of whose existence it is cognizant, begging them to co-operate in the work, and to have sections named in their respective countries similar to that in France. Finally, in connection with this subject, we may notice the current report that Mr. Henry Meiggs, the great South American contractor, has concluded a contract with the government of Nicaragua for the construction of a canal upon that route; and also that Mr. John C. Trautwine, whose name is familiar to all who are interested in the canal project, in a valuable paper upon the Darien International Canal, published in *The Polytechnic Review*, estimates the cost of the canal at this part of the isthmus at about $300,000,000, or about three times the cost of the Suez Canal. The same authority, speaking of the proposed Gogorza project of a route by way of the Rivers Atrato and Tuyra, above mentioned, says: "I have no hesitation in predicting that the survey will result in disappointment."

Another engineering project of considerable interest contemplates the cutting of a canal across the peninsula of Florida, in order to effect the junction of the Mississippi River and Atlantic Ocean. The project in question was presented at the late meeting of the International Geographical Congress, and was there most favorably commented upon. The following extracts from the several documents relating to this subject which were laid before the Congress will be read with interest: "The Associated Chambers of Commerce of the United Kingdom (affiliated now with those of Germany and France), in their recent report, after showing the enormous capabilities of the Mississippi Valley for maintaining the most flourishing trade in the world, point out among the obstructions prominently calling for removal the difficulties and expenses attending the transportation of merchandise in bond to the interior of the United States, and the excessive charges and taxes in shipping at New Orleans, which amount almost to a prohibition of the use of that port for general commerce." By no other way, it is further asserted, can these difficulties be avoided than by the adoption of the canalization scheme here alluded to. President Grant, in one of his late annual messages, says, in referring to it: "Such a route along our coast would be of great value at all times, but of inestimable value in case of foreign war. . . . Nature has already provided the greater part of the route, and the obstacles to be overcome are easily within the skill of the engineer." The proposed route is described as follows: From New Orleans to St. Marks, in Florida, a series of lakes, lagoons, waterways, all navigable, extend along the coast, separated here and there at long intervals by low necks of land, requiring but little more than skillful dredging to open the route to the Suwanee River in Florida. From the Suwanee to the Great St. Mary's River, which from the proposed point of junction pours its stately flood unimpeded by rock or shoal into the Atlantic Ocean, near the southernmost point of Cumberland Island, the distance is only thirty miles. By this plan, and at a moderate cost (for the canal would only need to have a depth of from seven to eight feet to float the largest steamers or craft frequenting these rivers), 20,000 miles of rivers and navigable waters, already swarming with craft, and eager for commerce, will be opened up, and, to use the words of one of the enthusiastic advocates of the enterprise, "the Southern planter or the Western granger from the remotest districts will be enabled to ship their produce by the easiest and cheapest mode of transportation known to commerce, and without breaking bulk, to ocean-going steamers and shipping of any tonnage lying in the safe harbors and anchorages of the Atlantic coast, . . . thus avoiding all the dangers now incident to the navigation of the Bahamas, the reefs of Florida, and the Gulf of Mexico."

The appearance of the Annual Report of the Suez Canal Company, which was made at Paris on the 27th of June last, enables us to bring forward the statistics of this improvement to the close of the year 1875. The report affords the information that the traffic on the canal has continued steadily to increase, amounting in 1875 to 1494 ships, with an actual tonnage of 2,940,708. (For 1874 the figures were 1264 ships; tonnage, 1,631,640.) The receipts for 1875 were 30,827,194 francs; and the expenditures, including interest, 29,727,047 francs. The company declared a dividend of 1 franc 88 centimes per share.

The past year has witnessed the practical abandonment of the system of steam canal-boats, of which so much had been anticipated. The company which was the recipient of the liberal prize of the State of New York for the best system, it appears, has gone into bankruptcy; while, on the other hand, the cable-towing system—known as the Belgian system—which was specially excluded from competition for the prize, has been in successful operation on the Erie Canal during the past year between Middleport and Buffalo, a distance of forty-two miles, giving great satisfaction. The charge to boatmen is the same as for horse-power, but the speed is two or three times as great. The merits of this system have been so thoroughly tested and well established abroad that it is difficult to understand in what respects it does not realize all the desiderata that can be asked for in the application of steam to canals.

Upon the East River Suspension Bridge work has been steadily pushed forward. The Brooklyn and New York towers have both been completed as far as possible before the making and placing in position of the cables, and preparations are now well advanced for the making of the cables from which the roadway is to be suspended. At the time of this writing, two working ropes (for pulling over the cable wires), and one cradle rope (to support the wooden "cradles" used as stations by the workmen adjusting the wires), are in their places. When the making of the cables will begin depends entirely, it is said, upon the delivery of the steel wire, for which specifications and invitations for bids have been sent to all the leading manufacturers of this country and Europe. Thirty-four hundred net tons of galvanized iron wire of No. 8 Birmingham gauge, capable of sustaining a strain of 3400 pounds without breaking, will be required. It is not deemed probable that with the utmost expedition the cables will be completed within less than two years from the present time; then the building of the bridge proper, with its six gigantic iron trusses, which will be supported from the cables; its great storm-cables, which will curve across each other twice beneath the floor; its subsidiary storm-cables; its mile and one sixth of roadways, passenger ways, and railroad tracks; its long approaches with their massive piers, etc., will consume two years longer in their completion. Under the most favorable estimates, therefore, it will require four years more to complete the bridge.

Work upon the Hudson River Tunnel, the projection of which enterprise we announced in our *Record* for 1874, is about to be resumed, having been interrupted for a considerable period by litigation arising out of the opposition of the Morris and Essex Railroad Company and the Jersey Shore Improvement Company. This litigation, it is affirmed, is now at an end, having terminated in favor of the Tunnel Company. Active operations will now be commenced on the New Jersey side from the foot of Fifteenth Street. Thence the tunnel will run in a northeasterly direction, passing under the river and the Christopher Street Ferry Slip. The New York entrance, it is said, will be located in the vicinity of Washington Square. The tunnel as proposed will be about two miles in length, and will have a road-bed of twenty-three feet, with two tracks, and the entire distance will be lighted with gas. It is proposed to employ two hundred laborers, and to continue the work day and night. The capital required to complete the work according to the plans proposed is $15,000,000, of which, it is affirmed, $10,000,000 have already been obtained. It is estimated finally that the enterprise as projected will be completed within two years. The tunnel will be used for passengers, but its main object will be to afford a rapid means of transporting freight to and from the railroad depots in Jersey City.

Among the more noteworthy engineering works in contemplation, we must not omit to mention the bridge over the Hudson River at Poughkeepsie, upon which, it is announced at the time of this writing, work will be begun at once. The contract for the building of the bridge has been awarded to the American Bridge Company of Chicago. Its estimated cost is placed at $4,000,000. The point fixed upon for the structure to cross is near the upper landing, or ferry dock, and at the intersection of the Poughkeepsie, Hartford, and Boston Railroad, and the Hudson River Railroad. The elevation of the bridge above high-water mark will be 130 feet, which will place it above the tallest masts of vessels plying the river. The entire length of the structure, with land approaches, will be 3400 feet.

From the annual report of the president of the Western Union Telegraph Company we glean the following facts concerning the pneumatic dispatch system, lately introduced by the company in New York City, viz.: During the past year the central office of the company in the city above named has been connected by means of pneumatic tubes with branch offices located at No. 14 Broad Street, No. 134 Pearl Street, and the Cotton Exchange. The tubes are of brass, each 2¼ inches internal diameter and ⅛ of an inch thick, and are laid under the pavements in the streets, at a depth of three feet. Messages are sent from the central office to the above-named branch offices by compressed air, and from the branch offices to the central stations by atmospheric pressure or exhaustion. The motive power is supplied by a 50 horse-power duplex engine, situated in the basement of the central office, which operates two double-acting air-pumps communicating with the compression and vacuum mains terminating in the operating-room. These are connected with the line of tubes by means of valves so constructed that carriers containing messages may be sent through the same in either direction by simply turning a cock connected with the compression or exhaust mains.

The usual pressure employed is six pounds to the square inch, and the time occupied in transmitting a box or carrier containing messages between the central office, corner of Broadway and Dey Street, to the office at No. 14 Broad Street (700 yards), is about 40 seconds; and between the central office and the offices at No. 134 Pearl Street and the Cotton Exchange (900 and 1100 yards respectively), about 1 minute and 5 seconds, and 1 minute and 20 seconds each.

The operation of the system is pronounced to be very satisfactory, resulting in a material saving of time and money, as compared with the old system of transmission by wire. The total cost of the improvement is placed at about $30,000, and the economy of the pneumatic system is so decided that, according to President Orton's estimates, fully one half of this outlay will be saved annually. An extension of the pneumatic system to other branch offices in the same city, when the traffic is large enough to warrant its application, is contemplated, and, when the value of the system has been more definitely ascertained, will doubtless be carried into effect.

The London *Engineer*, commenting upon this topic, affirms in substance that the excellence in both economy and rapidity of the pneumatic over the electric telegraph, when used for sending messages over comparatively short lines, has been fully demonstrated by the experience made with the system in the cities of London, Paris, Brussels, Berlin, and other European cities; the system, wherever introduced, being constantly enlarged, while in no instance has it been abandoned. In London, we are told by the same informant, there are now twenty-four distinct tubes of an aggregate length of nearly eighteen miles; and additions are now in progress which will increase this mileage one third. In London lead is preferred for the tubes, while in Paris iron is successfully used. In point of economy, the experience with the pneumatic system in London established the fact that during the past year the expense was barely two thirds of the amount which would have been required to pay the salaries only of the clerks needed under the old wire system, irrespective of the cost of wires and instruments. The utility of the pneumatic system for the transmission of letters to and from central to branch post-offices is obvious; while its perfect solution of the problem of local transmission should make us far less tolerant of the pole nuisance in our cities than we have heretofore been.

From the English journals we learn of the proposition to extend telegraphic communication across the African continent to the Cape. There is at the present time telegraphic communication from Alexandria to Khartoum, a distance of eleven hundred miles; and surveys for its further extension into the interior have already been made. The proposed route would lead under the Victoria Nyassa and Tanganyika Lakes, and thence down the Shiré and Zambesi Rivers to the sea, where a short ocean line would connect it with Delagoa Bay or Port Natal. It is claimed, though upon what ground does not appear to be very clear, that the undertaking, if it could be established and kept in working order, would prove to be exceedingly lucrative, and also—as must be admitted—that it would aid in many ways in opening up Africa to civilization and commerce. *Apropos* of the preceding, we may add that Mr. Donald Mackenzie with a party left England in the month of July, for the purpose of testing the feasibility of that gentleman's project (mentioned in our last yearly *Record*) of flooding the Sahara. The immediate purpose of the expedition was announced to be to make the necessary surveys preliminary to the turning of the waters of the Atlantic into the great sink or basin which is believed to extend from the valley of the Bella to Timbuctoo. Mr. Mackenzie, it is said, is very confident that a canal eight or nine miles long will suffice to accomplish the great operation of which he is the earnest advocate, and bring the mysterious negro metropolis within six or seven days' sail of the Thames. Thus far, however, no results appear to have flowed from the enterprise—the published reports all pointing to the fact that the expedition was an unsuccessful one. The question of the feasibility of the undertaking, however, does not appear to have been decided. At a recent reunion of the French Academy, however, M. de Lesseps concluded a summary of the report of Captain Roudaire upon this scheme in the following words: "We have reason to be satisfied with the results obtained by our compatriot savant; he is sure that there can be established a sea of from 25 to 40 meters in depth, and which shall cover an area of 16,000 kilometers (6200 square miles), with a length of 400 kilometers (250 miles) from east to west." Captain Roudaire estimates the cost of the work at 40,000,000 francs. Not a single oasis would be destroyed, and he claims that the revenue to be derived from the fisheries alone would pay a handsome interest on the invested capital.

From *Iron* we glean the following points concerning some extensive navigation improvements proposed for Manchester, England. The proposition in question involves the construction of a ship-canal from that city to the sea—an old project, but in a new and more practical form. Manchester is at present for customs purposes a port, but the canals connecting it with the sea *via* the Mersey are navigable only by barges. Mr. Hamilton Fulton, the originator of the present scheme, proposes to create a direct outlet for large vessels by utilizing the channel of the Irwell. This river flows through the heart of Manchester to a junction with the Mersey. The proposition is to widen the channel from Manchester to Warrington, and to excavate it to sufficient depth for vessels of 4000 tons burden. The course of the river is very sinuous, and by making straight cuts where the bends occur some nine miles in distance will be saved. From Manchester to Warrington, then, it is proposed to make use of existing waterways, widening, deepening, and straightening them, and dispensing altogether with locks. From Warrington, which is on the upper tidal portion of the Mersey, to the roadstead at Liverpool it is proposed to make a direct low-water channel, by which the ebb and flow of the tide would be kept to one course. This channel would be formed by constructing, in suitably selected positions, jetties parallel to its proposed course, so as to guide the current about the period of low tide in the desired direction. When completed, the channel would be buoyed and lighted, so that ships might pass, if necessary, at night. The scheme furthermore includes provisions for ample wharves and warehouse accommodation at Manchester and Warrington. The minimum depth of the canal at high-water neap tides is estimated at 24 feet, and the width between the quay walls at Manchester would be 450 feet. The cost of the improvement is placed at about £8,500,000.

Another great project which is being seriously agitated in France is that of a great maritime canal between the English Channel and the Mediterranean Sea. The latest advices upon this topic assert that the delegates of chambers of commerce have formed themselves into a commission to promote its execution, and have explained the feasibility and importance of the work to various members of the national government, who have the scheme under consideration. The canal proposed is to be sufficiently large for vessels of 250 or 300 tons; and the route is by the Seine, the old Burgundy Canal, and the Rhone. It is estimated that such a route would save about 1000 miles of navigation to all heavy articles, to which class of objects it would most probably be confined. The commission, adopting the estimates of reliable engineers, place the probable cost of the work at about sixty-five million francs (about thirteen million dollars); of which amount ten million francs would have to be expended on the Lower Seine, five millions on the Upper Seine and the Yonne, ten millions on the Burgundy Canal, and forty millions on the Rhone. The depth would be thirteen and a half meters on the Rhone, and two meters elsewhere. The locks would be 138 meters by 12 meters. Transshipment would in any case be necessary only at Lyons. The works can be completed in six years, and, it is urged, will retain in France much traffic that is likely to be diverted from that country on the completion of the St. Gothard Tunnel. A project of similar import, announced by M. Manier, under the name of the "*Grand Canal du Midi*," provides for a canal the whole distance. It would be divided into five sections: 1st, from Blaye to La Reole, a distance of 80 kilometers, with an average cut of 15 meters and a width of 180 meters; 2d, from La Reole to Toulouse, 175 kilometers, with an average cut of 78.18 meters and width of 100 meters; 3d, from Toulouse to Carcassonne, 90 kilometers, with mean depth of 141.4 meters and width of 80 meters; 4th, from Carcassonne to Narbonne, 60 kilometers, with mean depth of 62 meters and width of 100 meters; and, 5th, from Narbonne to the sea, 10 kilometers, with mean depth of 12 meters and width of 180 meters. The cost of this work, however, would be so prodigious as utterly to preclude the possibility of its being seriously undertaken. The *Pall Mall Gazette* figures the expense at over £1,000,000,000.

Another important water cut-off that has attracted discussion in the leading European journals is the project of a ship-canal from Bayonne, in the Bay of Biscay, through Toulouse to Ayde, two miles from the Mediterranean. It is urged that this improvement, if constructed, would make almost a bee-line from Plymouth to Malta, and save the long run down the coasts of Portugal and Spain, which amounts to several hundred miles. The London *Times* comments upon the project as follows: "With a ship-canal across the southern end of France, vessels could leave Liverpool, or any other English port, pass readily and quickly into the Mediterranean, and from that sea by the Suez Canal into the Arabian Sea, and thus reach our possessions in India."

Another project meriting notice is that of Mr. Henry C. Spaulding, an American engineer, who proposes to restore the ancient water-level of the Caspian Sea. He would commence the work at some point in the Caspian basin, where the surface is fifty feet below the Black Sea, and extend a level channel 500 feet in width westward, until 35 feet fall is obtained; from that point he proposes to continue the channel with a width of 150 feet, and a depth of 15 feet below the Black Sea, shoaling to 10 feet at its shore. The projector estimates that water will flow through this channel at the rate of eight miles per hour, and that with proper direction it will excavate a channel of the full size of the larger section (which shall be navigable) and fill the entire Caspian basin in about forty years. By diverting the Don into the Volga River, which could be accomplished, the projector estimates that the time of filling would be reduced to twenty-five years.

A pamphlet called the "Inter-Continental Tunnel" has lately been published in Madrid, advocating the scheme of tunneling the Strait of Gibraltar between Tarifa and Algesiras, on the Spanish coast, and Ceuta and Tangiers, on the African side. The more important points of this scheme are chronicled in our last year's *Record*.—The project of tunneling the Simplon Pass is again being mooted, a company for this purpose having been organized at Lausanne. The route of the projected work would be, it is said, from Brigue to Pelle, and its length 11.4 miles. A similar project, named in last year's *Record*, was abandoned in consequence of an unfavorable report from a commission of French engineers, who were appointed to investigate its merits.

A new ship-canal, which has long been projected for the benefit of the port of Amsterdam, was completed and thrown open to general commerce on the 21st of November, 1876. We condense the following facts relating to this work from the London *Times*: "The old route from Amsterdam to the ocean was by the Zuyder Zee, but the storms and banks of this dangerous gulf led, in 1819, to the construction of the North Holland Canal from Amsterdam to the Helder, the northernmost point of the province of North Holland, over fifty miles from Amsterdam. Why this route was chosen instead of the short cut now made is hard to understand. But provincial interests prevailed over the claims of mercantile capital, and it was reserved for our own days to bring Amsterdam, by a cut of fifteen miles, within an hour or two, at ordinary tides, of the German Ocean." The cost of this improvement is stated to have been

$10,000,000. The work of draining the Zuyder Zee, likewise, is said to be seriously contemplated by the Dutch government. This gigantic undertaking, if ever successfully completed, would reclaim some 500,000 acres of highly fertile land, and provide room for a population of 200,000 persons.

HEATING AND ILLUMINATION.

During the past year, although we may not chronicle any substantial advance in the practical application of gaseous fuel in the industries and the household, nevertheless the discussions of this most important theme, which have appeared in the several technical journals of prominence here and abroad, indicate that the problem is attracting the earnest attention of metallurgists and others. These discussions centred chiefly about the claims that have been put forward by the friends and advocates of the "water-gas process" of Lowe, the eminent value of which, we conceive, only the most progressive savans have fully appreciated. To properly comprehend the intensely practical bearing of this subject, a brief rehearsal of the causes of the enormous wastefulness of the systems of generating heat by means of coal, almost universally in vogue, will be appropriate.

The buyer of coal purchases, *ab initio*, from ten to fifteen per cent. of non-combustible and useless material, in the form of ash, with every pound of coal; while, on account of imperfections in the construction of furnaces, difficult of remedy under existing circumstances, perhaps as much as five per cent. more of combustible, in the form of dust or partially consumed fragments, passes through the grate unutilized. If even now, with so much waste as just indicated, we could really obtain all the useful effect of the remaining eighty or eighty-five per cent. of combustible, the result would be quite satisfactory; but such is far from being the case. The gasification of the coal, which is a phenomenon attending its combustion, involves the using up of a prodigious quantity of heat, the equivalent of the mechanical work performed by the particles in passing from the solid to the gaseous condition—which heat is lost so far as useful effect is concerned—being stored up in the gaseous particles insensible of thermometric measurement. The furnace gases, passing from the chimney at a temperature sometimes as high as 800° Fahrenheit, and carrying off with them immense volumes of unconsumed carbon in the form of smoke, is another material source of loss; and the introduction into the furnace of cold air and inert nitrogen, together with the absorption of heat by the furnace itself, and its conduction to surrounding objects and the atmosphere, completes the category of losses. Summing up all these items of loss, the fact that not more than fifteen to twenty per cent. of the thermal equivalent of the coal is obtained in well-constructed furnaces and steam-generators, is not at all surprising. The great and obvious advantage of gaseous over solid fuel—leaving the question of convenience out of sight—resides in the fact that the nature of the combustible permits of its instant and perfect intermixture with the air, by which a vastly more perfect combustion and the attainment of the highest possible temperature is insured—elements of the most vital importance in the majority of metallurgical and engineering operations requiring the use of fuel. These advantages find excellent illustration in the gas-furnaces of Siemens and others, which the best metallurgical authorities agree in pronouncing to be the least wasteful of all the methods heretofore devised for the consumption of fuel. In these furnaces, however, while acknowledging their eminent value, the atmospheric system of gasifying the fuel preliminary to its combustion is attended with the introduction into the furnace, and consequently into the gaseous product, of large volumes of inert nitrogen, which not only reduces the temperature of the furnace, but largely reduces the heating power of the gaseous product. The highest economy would, of course, be attained by any system by which the rapid gasification of the coal could be effected without the introduction of non-combustible diluents into the combustion-chamber. And it is just in the realization of this great desideratum of the metallurgist that the Lowe system, by which enormous volumes of heating-gas—hydrogen and carbonic oxide—are rapidly, cheaply, and continuously produced by the mutual introduction of superheated steam and incandescent carbon, claims attention.

The relation of this process to the province of illumination we have shown in another place. That we may not appear to be exaggerating its importance by dwelling upon it at too great length, we will close our discussion of the subject by a few quotations from one of the leading technical journals of the country:* "It is not of illuminating-gas, however, that we would now speak, but of heating-gas, for we are convinced that the question of the economical production of a good heating-gas once settled, the business of manufacturing it will greatly overshadow, by its enormous importance, that of making illuminating-gas. There is scarcely a use to which we apply coal in our cities that would not be benefited by the substitution of heating-gas, if the price were sufficiently low. It is said that water-gas, manufactured according to the Lowe system, can be made at a cost not to exceed fifteen cents per 1000 cubic feet, a figure which would allow of its distribution, in the enormous quantities required for domestic and manufacturing purposes, at a very low price, say, fifty cents per 1000 feet. The calorific value of this fuel calls for special attention, . . . for if water-gas, having more than four times the calorific value of Siemens' gas, can be produced here in the seaboard cities, where coal costs from four to five dollars a ton, by the Lowe or any other process at a cost of fifteen cents per 1000 feet, it must be evident that a new era in the development of industry is dawning upon us. It is not too much to expect that under these circumstances gas would take the place of coal for most uses. Its cleanliness, even if there were no great economy, would secure that result for domestic use; and the increased efficiency and convenience of gas, and the improved quality of the products obtained from it, would be sufficient to secure its adoption for manufacturing and smelting purposes. The highest economy in the use of fuel consists in supplying to the furnace, where the work is to be done, combustible gases only; . . . and since water-gas consists of carbonic oxide and hydrogen only, it seems quite evident that this is as favorable a condition in which to use a fuel as it is possible to obtain in the present state of our knowledge."

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* *Engineering and Mining Journal*, XXII., 293 et seq.

From the manifest tendency of modern utilitarianism to realize in practice the results that have been demonstrated to be possible in theory, we risk very little in the assertion that "the fuel of the future" will be gaseous; manufactured in the cities in large central establishments, distributed and "laid on" in our mills, factories, workshops, parlors, and kitchens, just as lighting-gas and water are at present supplied; and it is not exaggerating the importance of the process dwelt upon in the foregoing to affirm that it must be looked upon as having given a decided impetus to the world's progress in this direction.

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ANNUAL RECORD

OF

SCIENCE AND INDUSTRY.

1876.

A. MATHEMATICS AND ASTRONOMY.

ON THE CISSOID OF DIOCLES.

From the inaugural dissertation of Dr. W. Böhmer, entitled "Studies upon the Cissoid of Diocles," we quote the following method of describing this curve, as given by Sir Isaac Newton:

Through the centre of a circle whose plane is vertical draw a horizontal line and a vertical one. Lay off to the left a point at a distance from the centre of twice the radius of the circle. Along the vertical line let there glide one end of a bar whose length is the diameter of the circle, and whose opposite end is fixed at right angles to a second bar of indefinite length, and which is forced always to pass through the point just found on the horizontal line. Under these conditions the centre of the first-named bar describes the cissoid required. This method of describing the curve is easily executed mechanically, and by its means we are able, as was first shown by Diocles himself, to solve the problem which so troubled the Greek geometers, viz., the construction of a cube containing exactly twice the contents of a given cube. This problem is sometimes known as the problem of Apollo, or of Delphi, since at one time, it is said, Apollo,

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when standing in need of food, was ordered by the oracle of Delphi to construct an altar having double the volume of the well-known cubical golden altar of that oracle.—*Böhmer's Inaugural Dissertation*, 1874.

THEOREM IN THE EQUILIBRIUM OF FORCES.

If we have to deduce the resultant of any number whatever of forces acting upon a rigid system of points, we may begin by assuming for any given point, *n*, of the system two new forces equivalent to any other of the given forces, and which are parallel and equal to those, but have opposite directions, and therefore hold each other in equilibrium. We thus obtain successively for every pair of forces in the system an equivalent in the shape of a simple force acting at *n*, and a pair of forces which can give rise only to rotatory motion. If now the whole system of forces is to be in equilibrium, it is necessary not only that the simple forces acting at *n* shall be at equilibrium, but such equilibrium must also exist among the systems of pairs of forces tending to give rotatory motion. If equilibrium does not exist among the forces, three cases may be conceived, of which the most general is that in which both a motion of translation and a motion of rotation result from the application of these forces. In this case it is possible to replace all the assumed elementary forces by two resultants, which will not act in the same plane nor in the same direction.

This subject has been handled in an interesting inaugural dissertation by Dr. Dahmen, whence we derive the following theorems: First, an indefinite number of pairs of forces may be found, either of which will replace the original forces; and, secondly, if for each of these combinations of two inclined forces which are equivalent to each other, we connect the ends of the lines representing them, thereby constructing a tetrahedron, the solids so constructed will all have the same volume.—*Inaugural Dissertation of Dr. Dahmen*, 1874.

THE VALUE OF THE DOZEN.

As the derivation from the French *douzaine* implies, it is generally presumed that a dozen means twelve things, but in the Staffordshire potteries, and in the earthenware trade, queen's-ware in Philadelphia, crockery in other places, a dozen to this day represents that number of any special article which can be offered at any fixed price. That is, the price is fixed, and the number to the dozen varies. For instance, the pitchers which are called "jugs" in the trade are sold as 2, 3, 4, 6, 9, 12, 18, 24, 30, 36 pieces to each dozen, the price for a dozen being constant. The ordinary pitcher, holding a quart, is a twelve, or twelve to the dozen, while a pint pitcher is twenty-four to the dozen, and is so called when dealing in that size. Few of the articles of the trade are sold in dozens of twelve, plates being almost the only ones, and some of them are sold sixty to the dozen. Besides these curiosities in figures, the potters have peculiar names, muffins, twiflers, etc., that make up a trade language of itself. The quantities for dozens are, we think, yet preserved in the wholesale or package trade.—*Engineer*, XL., No. 1034, 281.

THE LAW OF RECIPROCITY OF PRIME NUMBERS.

In one of the letters of Legendre to Jacobi, which Borchardt has recently laid before the Berlin Academy of Sciences, it is said by Legendre, speaking of Gauss, that he is the one who, in 1801, wished to attribute to himself the discovery of the law of reciprocity published in 1785; and it is implied that to Legendre himself belongs the credit of that distinction, on account of his own memoir in 1785. In truth, however, Dr. Kronecker remarks, this theorem is due neither to Legendre nor Gauss, but to Euler, who first, although only by way of induction, arrived at that fundamental theorem, in the theory of quadratic residues, to which Legendre has given the name of the law of reciprocity. This theorem was, in fact, partially known to Euler in 1744. Legendre has, indeed, materially improved and added to what Euler had done; while to Gauss is reserved the completion of the whole work with a master's hand.—*Monatsbericht k. Akad. der Wiss., Berlin*, 1875, 267.

REUSCHEL'S TABLE OF PRIME NUMBERS.

In the April number of the monthly Bulletin of the Berlin Academy of Sciences, Kronecker gives a very full treatment of some mathematical problems, and at the close makes some remarks upon the table of complex prime numbers completed by Dr. C. G. Reuschel, and published by the Berlin Academy, from which we gather that Dr. Reuschel's works contain in the greatest completeness, and in a well-arranged series, the principal results of some twelve years of laborious computation which the author had undertaken in order to lay a foundation for the analysis of the prime numbers by deriving them from the roots of unity on the basis of Kummer's theory. In the study of the theory of the complex numbers, the computations are so exceedingly difficult and laborious that it is scarcely possible for individual investigators to provide themselves in any special case with the necessary material of observation in order to find therein some base for theoretical investigation. Therefore the computations of Professor Reuschel have frequently proved to be valuable preliminary labors, and bring praise to the perseverance and devotion with which he has for so many years labored on his work. Unfortunately, the accidental death of Reuschel, on the 22d of May of this year, in the sixty-third year of his life, deprives him of the pleasure of reaping that benefit from his work that should naturally have been his.—*Monatsbericht k. Akad. der Wiss., Berlin*, 1875, 238.

HYPERBOLIC FUNCTIONS.

In pure mathematics, we notice the publication, in the Memoirs of the Scientific Society of Bordeaux, of an essay by Loisant on hyperbolic functions, in which he especially investigates the correlation between the co-ordinates of any point of an ellipse and any point of the hyperbola having the same axis. His investigations, which seem to have been carried out under the advice of Realis, lead apparently to numerous curious and novel mathematical relations susceptible of being practically useful in very many problems of applied mathematics.—*Mem. Sc. Soc. of Bordeaux*, 1874, 101.

CURIOUS CURVES AND EQUATIONS.

In a memoir on a certain class of transcendental curves, Professor H. A. Newton, of Yale College, states that algebraic curves have hitherto been studied more than transcendental. A few of the latter have been given in the textbooks, but attempts to classify the numerous varieties of transcendental curves have been rare. From the form of a transcendental curve it is not easy to state an equation that can represent it. The simpler inverse problem of describing the curve from the given equation is naturally the first to be undertaken. The forms that thus result may, when compared with a given new or unknown curve, suggest the form of the equation that belongs to the latter. In order to present a number of curves for future study, Professor Newton has therefore selected a single one of the numberless transcendental equations, and has in a series of twenty-five plates, embracing one hundred and fifty figures, presented a few of the very many plane curves which this one equation furnishes. Among the curves figured by him are some which reduce to a simple series of consecutive rows of isolated dots; others reduce to systems of intersecting straight lines. Other cases represent systems of screws and circles. The more complicated figures present innumerable suggestive and beautifully regular patterns, differing entirely in their characteristics from those ordinarily presented by the eccentric lathe, as applied to the ornamentation of bank-notes.—*Trans. Connecticut Academy of Sciences*, III., 97.

DÖLLEN'S METHOD OF DETERMINING LOCAL TIME.

It is well known that the method of determining the time, and consequently the longitude, by the use of the transit instrument, not in the meridian, but in the vertical of the polar star, has long been enthusiastically advocated by Döllen, and the numerous geodesists whom he has instructed at the Imperial Observatory at Poulkova. A short memoir on this subject was published by him in 1864, on the celebration of the twenty-fifth anniversary of the founding of that magnificent institution. This memoir subsequently became available to Americans through Mr. Abbe's translation published by the Hydrographic Bureau of the Navy Department. Döllen has now published a much more complete treatise, whose appearance has been delayed for various reasons, but by virtue of which delay the author states he is enabled now to say with perfect assurance that the method advocated by him has stood every test of experience, and must now be considered as the best that is known. A third memoir is promised by him on the same subject, and will be looked forward to with great interest. His confidence in the excellence of the method of determination of time in the vertical of the polar star is especially based upon the experience gained in the summer of 1868, and in subsequent years. Previous to this time, in fact, the few transit instruments that had been specially adapted to his method were required for use in other places; and it was only in 1868 that some of them could be employed by the persons who were acquainted with his methods, in connection with the measurement of a degree of longitude under the sixtieth parallel of north latitude. In the fall of the same year, eight astronomical stations were occupied by his geodetic students in the neighborhood of the Duderhof mountain, near St. Petersburg, whose positions were determined in connection with the investigation of the local deviation of the pendulum.—*Döllen, Die Zeitbestimmung. Second Memoir.*

ACCURACY OF CHRONOMETERS.

An excellent investigation having been made by Lieutenant Martin, of the French navy, into the accuracy of the chronometers actually used on two voyages of circumnavigation in 1866 to 1868, he states that, first, in most cases, it is necessary to take account of the acceleration in the daily rate of the chronometer, as proportional to lapse of time. Second, that in relying upon one or two chronometers we risk the chance of doubling our errors, if we make any empirical correction for the temperature. Third, with three or more chronometers, we should make a correction for the temperature.—*Revue Maritime et Coloniale, Sept.*, 1875, 402.

ON TERRESTRIAL REFRACTION.

A series of observations has been made by Stebnitzky, colonel on the staff in the Russian army, looking to the improvement of our knowledge of terrestrial refraction. His observations were made mostly in the plains to the north of the Caucasus, and in a mountainous country. The instrument employed was a vertical circle, made by Messrs. Ertel, at Munich. The reduction of the observations and the deduction from them of some corrections to the terrestrial refraction has been made by Sawitsch. In general, he finds that the observations have been made between the epochs of tranquil images of the stars in the morning and evening; and that perhaps the terrestrial refractions thus observed will come out smaller than the normal refraction. Some changes in the co-efficient of refraction seem to take place so suddenly that they can only be explained by supposing a derangement of the instrument. Excepting these, the remainder of the determinations merit great confidence. In general, the formulæ of Struve accord very well with these later observations made in the mountains of the Caucasus. The formula proposed by Sawitsch gives the refractions a little too great.—*Bulletin Acad. Impériale des Sciences, St. Petersburg,* 1875, 318.

CELESTIAL PHOTOMETRY.

Lindemann has investigated the merits of the method of estimating the brightness of stars as taught by Argelander, as compared with the measurements of the stellar-photometer invented by Zöllner. He has chosen to this end to make observations both with the unaided eye and with Zöllner's instrument upon the interesting variable star Algol, or Beta Persei. His observations began in 1870; but in the course of four years he was only able to secure observations of six Algol minimi suitable to his purpose. A review of his work by the eminent observer of variable stars, Schönfeld, shows that the naked-eye estimates made by Lindemann belong to the best class of work of that nature; and that his observations made by means of Zöllner's photometer can not be considered superior, and are even barely equal thereto, so far, at least, as accidental errors are concerned. With regard, however, to systematic differences in these two methods of observation, Lindemann's research yielded the most interesting conclusions, as showing that exterior influences appear to affect the instrumental observations less than those with the unaided eye; the latter make the epochs of Algol's minimum brightness come somewhat earlier than the former, but the photometric measures and the naked-eye estimations agree somewhat better after the minimum has passed than before. By comparison of his own estimates, Schönfeld finds that the diminution of brightness before the minimum is reached is, as given by him, slightly greater than that observed by Lindemann; while, on the contrary, after the minimum has passed, Schönfeld's estimates are lower than those of Lindemann. The observations of Lindemann are a contribution of the highest value to our knowledge of the variability of Algol; and, as Schönfeld says, "similar works should be prosecuted the more diligently in proportion as the number of astronomers diminishes who occupy themselves with this interesting star."—*Vierteljahrsschrift der Astronomischen Gesellschaft*, X., 203.

ON THE THEORY OF THE ABERRATION OF LIGHT.

Villarceau states that he has been making a research into the theory of the aberration of light, and the influence upon it of the absolute movement of the solar system. His mathematical investigations of the subject having been concluded without regard to the methods of Gauss and Bessel, he has been independently led to conclude, in opposition to them, that the absolute movement of the solar system will have an effect other than simply to change by constant quantities the position of all stars; and he shows that in order to determine the four unknown quantities, viz., the true constant of aberration, and the three rectangular components of the movement of the solar system, it is necessary to have at least four values of the aberration by observations of four stars not situated upon the same great circle; and the observations will be best suited to the purposes in hand if they are made at two astronomical situations whose latitudes are 35¼° north and south of the equator. If we would increase the accuracy of our result by increasing the number of stars, they should be distributed in groups of four, the individuals of each group being six hours apart in right ascension, and respectively 35° north and south declination. By a proper combination among the observatories at present existing in the world, it would, in fact, be possible to realize such a determination of the constant of aberration, without considerable expense, in the course of a single year.—6 *B*, LXXXI., 165.

CORRELATION OF SOLAR AND TERRESTRIAL PHENOMENA.

In some remarks on the connection between the changes that take place on the sun, and on the earth, and forming a portion of his address as President of the British Association for the Advancement of Science, Professor Balfour Stewart indulges in the following speculation: He says we are all familiar with the generalization of Hadley, viz., that the under-currents of our atmosphere sweep along the surface of the earth from the poles to the equator, while upper currents return from the equator to the poles. These are caused by the unequal temperatures of the respective portions of the earth. They therefore have a reference, not so much to the geographical equator and poles, as to the hottest and coldest regions. These currents have both annual and daily oscillations. On the other hand, the earth is a magnet, and the existence of these general currents in our atmosphere suggests an explanation as to the origin of terrestrial magnetism. We bear in mind that rarefied air is a good conductor of electricity. The return trades that pass above from the hotter equatorial regions to the poles of cold, consisting of moist, rarefied air, are therefore to be regarded in the light of good conductors crossing the so-called lines of magnetic force. They therefore are the vehicle of electric currents, such as will of course react upon the magnetism of the earth; and there is, according to Stewart, a similarity between the peculiarities of the magnetic variation and the annual and daily variations of the winds, such as invites a further scrutiny. A similar parallelism exists apparently when we compare the storms in the atmosphere with the magnetic storms recorded by the needle.—*Balfour Stewart's Address at Bristol*, 1875.

CONFLICTING VIEWS OF SECCHI AND LANGLEY IN REGARD TO THE SUN.

Professor Langley, of the Alleghany Observatory, having lately published in the *American Journal of Science*, and the *Memorie degli Spettroscopisti Italiani*, an article on the "Comparison of Theories of Solar Structure with Observation," in which certain supposed views of Father Secchi, of Rome, were referred to, the latter has replied at length in subsequent numbers of the Italian journal, commenting upon the researches of the American observer, and explaining his own views in such a way as to lead us to suspect a sudden conversion to views opposed to those he has advocated for so many years.

Father Secchi states his present view, which is, briefly, as follows, that a sun-spot is the product of an eruption on the sun, somewhat analogous to that of a terrestrial volcano.

The first stages of the eruption are, according to this statement of Father Secchi's latest opinion, occupied by the ejection of matter from the crater, which is what we call the *umbra* of the spot, and it is with these stages that the rose-colored flames or eruptions seen in the spectroscope are to be associated. This term "crater," however, is not to be understood as conveying the idea of a solid solar crust or shell, from which the jets escape into the chromosphere. On the contrary, he here entirely agrees with Professor Langley's view that the visible surface of the sun is essentially vaporous and cloudlike. This admitted, the analogy with the terrestrial volcano is elsewhere very close, for there is in both a second or intermediate stage during which the paroxysmal outbursts have ceased, though the ejected matters have not entirely stopped flowing from the crater; and a third stage, when, the eruption being fairly over, there is a gradual closing and extinction. Father Secchi claims that the observations of Professor Langley are quite consistent with this view, and adds that they are, in fact, very gratifying to him, as he is disposed to welcome them as bringing unexpected testimony to the truth of statements he made himself at one time, and which were then disputed. These American observations, then, may be called "beautiful," rather than fundamentally "new," in the opinion of Father Secchi, who believes himself to have more or less anticipated a large part of them; and, though agreeing that the resolution of the filamentary structure has been carried at Allegheny a step beyond that which he has reached at Rome, deems that this is accounted for by the fact that the American observer has the use of a larger telescope than the Roman observatory possesses.—*Mem. Soc. Spettrocopisti Italiani*, 1875, *January and February.*

ON AN ANCIENT ECLIPSE OF THE SUN.

Dr. E. Bretschneider, of Pekin, communicates to *Petermann's Mittheilungen* an account of the journeys performed by four Chinese scholars in the first half of the thirteenth century. Of these, the most interesting is that of Tschang-tschung, in 1221 and 1224. This distinguished monk of the Taoist order was at that time about seventy years old, and at the height of his renown. In the course of his journey he experienced a total solar eclipse on the 23d of May, 1221, while traveling along the right bank of the Kerulun River. If the exact time and the place of the totality can be derived by Dr. Bretschneider from the Chinese record at his disposal, we shall have here one more contribution to our exact knowledge of the relative movements of the sun, earth, and moon. —17 *C*, XXI., 1875, 373.

TOTAL SOLAR ECLIPSE OF DECEMBER 11, 1871.

The government of India equipped an expedition, under the direction of Colonel Tennant, R. E., to observe this eclipse, and the results of the observations by Colonel Tennant, Captain Herschel, Mr. Hennessey, and others, are printed in the *Memoirs of the Royal Astronomical Society* (vol. lxii.), accompanied by four plates reproduced from photographs near totality. Spectroscopic as well as photographic records were made, and the polariscope was also employed. From these data Colonel Tennant's conclusions are derived, which he states as below:

"The following, then, seems to be the constitution of our sun. There is a nucleus which gives out continuous white light, like solid or liquid bodies, and even dense gases; surrounding this is a layer of heavy vapors, intensely heated, but far less so than the nucleus; in which, if a state of equilibrium could exist, the heavier vapors would be lowest. Above this is a layer of hydrogen of very slight density, accompanied by that gas which gives the line D_3. Still farther up these gases, in a cooler state, become mixed with what gives out the green line K 1474, and lastly that alone seems to remain. . . . We do not know any thing of the substance producing the chromospheric line D_3. Professor Respighi's observation at Podoocotta would go to show that it is inseparable from the hydrogen of the chromosphere. The substance, however, producing the green line K 1474 is one of the most interesting. We not only meet with evidence of its existence in the sun, but when the higher layers of our own atmosphere are reached we find at the great height at which auroras take place a substance which gives out a light apparently identical. Angström and Kirchoff have assigned the power of giving this line to the vapor of iron; but it seems nearly impossible that at the low temperature which we know must exist in the upper strata of our atmosphere there can be iron vapor. Is it possible that iron possesses the property of occluding the gas whose distinctive line is K 1474? If it be so, this gas must be under ordinary circumstances of temperature and pressure almost immeasurably rare."

ON THE TEMPERATURE OF THE SOLAR SPOTS.

In presenting to the Paris Academy of Sciences the results of some of his observations upon the temperature of the sun, Mr. Langley, of Pittsburg, says that he has endeavored to repeat the observations made by Professor Joseph Henry in 1845, and Father Secchi in 1852. He has employed an ordinary achromatic refractor, after having first experimented with and laid aside a fixed horizontal telescope whose lenses were of rock-salt. The differences of temperature have been measured by an extremely delicate thermopile made of extremely small bars of bismuth and antimony, the exposed face of which has a diameter less than the sixth part of an inch, within which area are seen the ends of sixteen pairs of bars. This thermopile is connected with a Thomson's reflecting galvanometer. This combination possesses such an extreme sensibility that the galvanometer is, in spite of ordinary precautions, continually registering foreign radiations, such as would render indistinct the delicate phenomena that are the subject of the investigation. These disturbances are best removed by inclosing the pile within a blackened cylinder filled with water at a constant temperature. The image of the sun being about twenty-four inches in diameter, the thermopile can be placed at any part thereof with great accuracy. A second similar thermopile being placed in any other portion of the solar image, and connected with the same galvanometer, Mr. Langley was, by this differential arrangement, enabled to make the desired measurements. His observations confirm fully the original observations of Professor Henry, and have led him to further interesting results. From the known effect of the diminution of the light of the sun toward its borders, it seemed natural to conclude that a proportional diminution of the heat of the sun would be experienced. Mr. Langley, however, finds that the heat does not become insensible after we pass away from the visible border of the sun, but continues sensible at a distance of at least thirty seconds of arc, which corresponds at the sun to fifteen thousand miles. He finds also that the whole amount of heat sent from the ring of photosphere around the sun is less than that received from the nucleus of a single solar spot.—6 *B*, LXXX., 748.

SOLAR SPOTS AND TERRESTRIAL PHENOMENA.

Fritz, so well known by his studies upon the aurora, and especially by his great chronological catalogue of auroræ, states that, after renewed investigation and comparison of thunder-storms in various portions of the earth, he is again forced to the conclusion that there is no perceptible definite connection between the frequency of thunder-storms and auroras, nor between these storms and the solar spots, so far as observations from over thirty places can afford any result. Some of the series employed by him reach back to 1755. He has also studied the series of observed heights of rivers, especially the Seine, at Paris, the Rhine, the Elbe, the Donau, and other German rivers. This comparison shows that between 1785 and 1844 there was a comparative coincidence in the periodical changes of depth of water and sun-spots, but that the law is reversed from 1844 to 1867, similarly to the reversal found by Professor Wolf, who compared the rainfall itself with the sun-spots.—*Klein's Wochenschrift*, 1875, 238.

ON THE RELATIVE TEMPERATURE OF VARIOUS PORTIONS OF THE SUN.

In a second communication to the French Academy of Sciences, Professor Langley, of Pittsburgh, has given the results of some measurements of the relative temperatures of the solar surface. This subject was first carefully investigated by Laplace, who showed that the solar atmosphere absorbed the light that emanates from its nucleus to such an extent that were its atmosphere removed we should receive twelve times more light than at present. The parallelism that exists between the phenomena of light and heat would lead us to expect a result somewhat of the same sort, in case we could measure the heat of the sun. Professor Langley has therefore compared the apparent temperature of every portion of the solar disk, as Bouguer did for the solar light a hundred years ago. He finds the temperature to go on diminishing as we proceed from the centre to the limb of the sun; the heat is absorbed less than the light, and the principal absorption of the heat is confined to an extremely thin shell close to the photosphere. The heat that is received from the sun's edge is relatively much greater than the quantity of light. It would seem, therefore, that both at the solar limb and at the nucleus of the solar spots the light is cut off by the solar atmosphere in a much greater proportion than the heat. From the nucleus of a spot we receive fifty times more heat than light; and it becomes evident that the solar atmosphere exercises a selective absorption to a very marked degree. Father Secchi has stated that a decided difference in temperature is found if we compare the temperatures at the solar equator and the solar poles; but Mr. Langley finds, on the contrary, that the temperature is sensibly the same at all portions of the solar limb.—6 *B*, LXXX., 819.

ON OBSERVATIONS OF SHOOTING-STARS FROM BALLOONS.

In a balloon ascension made on the first of August, De Fonvielle states that seven passengers accompanied him, the ascent taking place at ten minutes of ten in the evening, and the descent at a quarter of four in the morning. The aeronauts had no lamps with them; but the starlight permitted them to recognize the route they followed. No instrumental observations could be made, but in lieu thereof the shooting-stars appear to have been carefully observed. Of these forty-two were counted in all parts of the heavens, some very brilliant. Eight or nine fell from the zenith in sensibly vertical paths. The evening twilight lasted until half-past ten; the morning twilight began at two o'clock.—6 *B*, LXXXI., 204, 205.

OBSERVATIONS OF THE SHOOTING-STARS OF THE 10TH OF AUGUST, 1875.

The shooting-stars that appear on the night of the 9th, 10th, and 11th of August are ordinarily known as the Perseides, inasmuch as their radiating point is in that constellation. They have been carefully observed in France during the past month; and from the observations made at Toulouse by his assistants, Tisserand concludes that besides the principal radiant point in right ascension 47° and declination 56°, two other secondary radiant points existed, the positions of which were respectively right ascension 57°, declination 51°, and right ascension 64°, declination 63°. At least three fourths of the 1200 stars observed by them belonged to the first or principal radiant.—6 *B*, LXXXI., 317.

THE ABSORPTION OF THE SOLAR ATMOSPHERE.

Professor S. P. Langley, of the Allegheny Observatory, as a result of the photometric study of the solar surface, finds that the brightness of the umbra of the solar spots is considerably greater than that hitherto accepted. The blackest umbra being, according to him, from five to ten thousand times as bright as the full moon. The light of the sun is absorbed by the solar atmosphere in a greater proportion than is its heat. About one half of the radiant heat of the sun is absorbed, or suffers internal reflection by the atmosphere of the sun itself. This atmosphere is comparatively thin; new matter is constantly being added to it or taken away from it by the continual changes of the interior surface. The alteration in its absorptive power would materially affect the temperature of our globe, so that even the existence of life on our earth is evidently dependent upon the constancy of the absorption of this solar envelope. If there are, then, any cyclical changes in the depth of this solar atmosphere, they would be accompanied by corresponding cyclical alterations in the earth's temperature.—12 *A*, XII., 443.

VOGEL'S POSITIONS OF CLUSTERS AND NEBULÆ.

Dr. H. C. Vogel, already distinguished by his accurate observations of the positions of nebulæ and clusters at Leipzig in 1867, was engaged by Dr. Bruhns, the Director of the Leipzig Observatory, to co-operate in a work which that observatory had undertaken, namely, the re-observation of the stars down to the tenth magnitude, between the north declinations of 9° 50′ and 15° 10′. Dr. Bruhns so extended the plan proposed by the German Astronomical Society, which was concerned only with star-positions, as to include the determination of the position of all nebulæ and clusters within the zone, and this Dr. Vogel has executed. Dr. Bruhns's plan also includes re-observation of the double stars in his zone. Three hundred and five nebulæ occur in this zone. Of these many have been previously well determined by D'Arrest and others, and Dr. Vogel accordingly devoted his labor to the nebulæ whose positions were uncertain, one hundred and forty in number. Each nebula was observed on two different nights at least, and Vogel finds the probable error of his final positions to be in R. A. $= \pm 0.09^s$, in $\delta = \pm 1.1''$. Between Vogel and Schönfeld the same personal difference remains which existed in 1867. Supposing both observers to have the same accuracy, the probable errors of a concluded position do not exceed 0.14^s in R. A., and $1.5''$ in declination. It will be noted here that these determinations are surprisingly accurate, and that the observations of D'Arrest, Laugier, Schultz, Schönfeld, and Vogel will serve to determine the proper motions of nebulæ if these are of important magnitude. Three star-clusters (G. C. 905, 1361, and 4440) have also been studied, and twelve nebulæ drawn. The nebula G. C. 2211 = h. 761 is probably variable in brightness.

SUPPOSED CHANGES IN THE OMEGA NEBULA.

Professor Holden has recently published the results of a careful study of all published drawings and observations of this nebula (R. A. 18^h 12^m, N. P. D. 106.2°). The method adopted in the discussion of the drawings was peculiar, although perfectly simple and elementary. All the published drawings were photographed on the same scale, and in such a way that they represented the aspect of the nebula as seen in a *refractor*. They became thus strictly comparable, and any variation between the several drawings was at once evident. In all such delineations such differences exist, and the only difficulty in their discussion is to distinguish between real changes in the shape of the object itself, and apparent changes due to lack of fidelity in the drawing.

Professor Holden seeks to avoid this great difficulty by inquiring how the nebulosity in each drawing is situated with regard to lines joining certain pairs of stars, and terminated by these stars. It is probable that in a careful drawing no observer would lay down a certain star *outside* of a nebula when his telescope showed it *inside*. In this way the successive drawings of this nebula, from 1833 to 1875 (seven in all), have been studied, and the conclusion is arrived at that "the western end of this nebula has moved relatively to its contained stars from 1833 to 1862, and again from 1862 to 1875, and always in the same direction."

The author also directs attention to the Trifid Nebula (G. C. 4355), which was suspected by Sir John Herschel to have a proper motion. Professor Holden confirms Herschel's suspicion. This is the first large proper motion detected in any nebula, and is of great interest in the theoretical questions relating to the distance and nature of these bodies. Both of these nebulæ will receive further attention.—4 *D*, *May*, 1876, 341.

COLORS OF DOUBLE STARS.

In the *Astronomical Register* for May, 1876, Mr. Sadler gives a list of sixty-three double stars, with the colors that he has noted for the components. His observations were made with a 6½-inch silvered-glass reflector (silvered-glass reflectors possess considerable advantages in such investigations, as the natural color of an object is less affected than when a refractor is used), and appear to have been made with great care. An interesting comparison with the work of former observers is given at the close of his paper. Smyth, Sestini, Herschel, South, Webb, Struve, and others are full of notes on this subject, which deserves attention, and is well suited to amateur observers.

THE RUGBY (TEMPLE OBSERVATORY) AND MR. GLEDHILL'S CATALOGUES OF DOUBLE STARS.

In the *Memoirs of the Royal Astronomical Society* (vol. xlii.) Messrs. Wilson and Seabroke, of Rugby School, have given to astronomers the results of their micrometric measures of double stars during the years 1871–74. The measures were made with the 8¼-inch equatorial by Alvan Clark which was formerly used by Dawes. Rugby has selected those even-numbered stars of Struve's Catalogue which are south of 50° of N. declination for subjects of observation, and records 1152 measures of these. The observations show great fidelity and skill on the part of the observers, and are a valuable contribution to this branch of astronomy.

Many interesting binaries were observed, some of considerable difficulty; and this catalogue will be an essential help to investigators of orbits and to double-star observers. In the same volume Mr. Gledhill, of Mr. Edward Crossley's observatory at Halifax, gives the results of his measures of 484 doubles, which were made in concert with those of the Rugby Observatory, Mr. Gledhill observing those stars not taken by Rugby, in a list common to both observatories. Particular attention has been paid to the subject of binary stars, and it is announced that a work is in preparation on this topic.

Already the joint labor of these two observatories has decided the question of orbital motion in many cases.

ON THE ORBIT OF THE DOUBLE STAR Σ 634.

Otto Struve states that in preparing his micrometric measurements of double stars for publication, he came upon the star Σ 634, whose movements seemed to have especial interest. When the elder Struve compiled his well-known catalogue of new stars, the distance of the two from each other was nearly 37″. Their brightness was, on the average, as deduced from many estimations, respectively 4.5 and 7.9. To the great distance of these stars from each other is to be attributed the fact that they have been measured but seldom by good observers. At present the stars are about 20″ apart; their respective proper motions are nearly identical, but in direction are opposite to each other, and we are obliged to conclude that the two bodies may, in all probability, have some physical connection with each other, and are not merely optically double.—*Bulletin Acad. Imp. des Sciences, St. Petersburg*, V.

THE COMPANION OF SIRIUS.

It has been noted that the Washington observations of Clark's companion of *Sirius* do not agree with the computed positions from the theory of Auwers; the corrections to Auwers are—

1872.25	−5.6° in p	+0.40″ in s.
1874.18	−6.3° in p	−0.46″ in s.
1875.24	−7.2° in p	−0.72″ in s.

This is confirmed by the measures of Mr. W. Erck, of Ireland, who, under date of March 21, 1876, gives its position-angle as 55°. The Washington observations for 1876 give the position-angle from measures taken from January 3 to April 8, as follows:

Hall (6 nights)	$p=55.22^{\circ}$
Holden (6 nights)	$p=54.53^{\circ}$
Mean	54.88°

The distance is still greater than 11″.

Lassell's new companion (more properly Marth's, as Lassell did not observe it; see *Mem. R. A. S.*, vol. xxxvi., p. 38) was seen by Mr. Erck $p=130^{\circ}, s=75''\pm$. Marth's measure of 1865, Jan. 14, gave $p=127^{\circ}, s=60''\pm$.—12 *A*, *March* 30, 1876.

THE VARIABLE STAR BETA PERSEI (ALGOL).

Dr. Julius Schmidt, Director of the Observatory of Athens, in continuance of his publication of the results of his long-continued observations of variable stars, has announced the definitive results of a thirty years' series (1845–1875) of observations on the variability of *Algol*. In the thirty years 285 minima have been observed, or an average of more than nine each year, and it is especially noteworthy that there is not a single year without at least three observations. These observations have been steadily pursued, whether at Bonn, Hamburg, Olmütz, in Greece, or at sea, with veritable assiduity. Argelander and Schönfeld have also carefully followed up this star, and Schmidt finds for the probable error of a single determination (of the time of minimum)—

Argelander	*p. e.*	$=\pm 6.04^{m}$	from	50	observations.
Schmidt	"	$=\pm 8.08^{m}$	"	188	"
Schönfeld	"	$=\pm 4.56^{m}$	"	55	"
Combination of all observers	"	$=\pm 7.01^{m}$	"	288	"

As an indication of the constant differences of these three observers, Schmidt deduces from simultaneous observations:

Schmidt—Argelander $=-3.89^{m}\pm 1.72^{m}$, from 21 observations (1846–58).
" —Schönfeld $=-0.79^{m}\pm 2.68^{m}$, " 17 " (1855–75).

The final result for the period of *Algol* is 2 days, 20 hours, 48 min., 53.60 sec.—38 *C*, No. 2077.

THE MOTION OF STARS TOWARD OR FROM THE EARTH.

It is known that the method of determining the motion of stars toward or from the earth by means of the displacement of a line in the spectrum of the star relatively to the position of the same line in the spectrum of a Geissler tube held before the telescope has promised great results, and in the hands of Huggins and Vogel has yielded apparently reliable information. Secchi took up the problem in 1863, but without reaching satisfactory results, and attributed his negative conclusions at that time to the great difficulty and delicacy of the research. It is known, too, that the theory of Doppler (1842), upon which the principle of this method of research depends, has been seriously questioned by Van der Willigen. At Greenwich, during the past year, the question has been taken up on its observational side, and the results reached, which are often contradictory, have been published in the *Monthly Notices of the Royal Astron. Society*, vol. xxxvi., p. 30.

In view of these known difficulties, the recent researches of Secchi on this point are of great importance. He has prepared a table (a portion of which is reproduced below) in which the results of the various observers are exhibited. The sign + shows that the star was moving away from the earth, and – that it was approaching it.

STARS.	OBSERVERS.			
	Huggins.	Greenwich.	Secchi.	Vogel.
Sirius..........	+	–	–	...
α Lyræ...........	–	–	0	–
Procyon........	+	–	...	...
Castor.........	+	+	0	...
Regulus........	+	–	0	...
η Ursæ Majoris..	+	–	–	...

In his considerations upon the complete table, Secchi makes the following remarks:

1. That at Greenwich almost all the results are negative, a positive result being the exception; 2. The different days' results are quite discordant; 3. Huggins's results are nearly all +; 4. The results of Huggins as to the motion of Coggia's comet are not in accord with the known direction of this comet's motion; 5. The mean numerical results of the various observers are widely different. In view of these discordances, Secchi has made experiments upon *Sirius* with the object of determining whether there may be a *systematic source of error, either in the instrument or in the manner of observing, which may cause the displacement of the spectral ray.*

These experiments showed that a displacement could be produced on *either* side of the line of comparison by varying the method of observation, and Secchi comes to the conclusion that such systematic errors may appear without the observer having any sure means of detecting their existence. He points out that the agreement of a long series of such observations is no sure test of the star's motion, since the observer always places the instrument in the position where the vision is best. Further researches on this point are then most important.—6 *B*, *April* 3, 1876, 761.

DIMENSIONS OF THE SATELLITES OF JUPITER.

Taking a mean of the measures of the diameters of the satellites of *Jupiter*, by Struve at Dorpat and Engelmann at Leipzig, we have for the apparent diameters of the four satellites at the mean distance of the primary—

I. 1.048″; II. 0.911″; III. 1.518″; IV. 1.278″.

With a solar parallax of 8.875″, the true diameters in English miles will be—

I. 2435; II. 2115; III. 3514; IV. 2970.

The angular diameters at the centre of Jupiter are—

I. 31.4′; II. 17.1′; III. 17.8′; IV. 8.6′;

and the mean distance from *Jupiter's* centre—

I.	266,700 miles.	III.	676,800 miles.
II.	424,300 "	IV.	1,190,400 "

—12 *A*, *Feb.* 10, 1876, 288.

THE SATELLITES OF SATURN.

The 26-inch Clark equatorial of the Naval Observatory of Washington has been employed during the past opposition of *Saturn* in observations of his eight satellites. The results of five months' observations by Professor Hall are published in the *Astronomische Nachrichten*, No. 2076, and are very complete; especial attention has been paid to *Japetus* and *Titan*, with the object of determining the mass of *Saturn*. *Hyperion* (the faint satellite discovered by G. P. Bond) has been observed no less than forty times in this single opposition—an unprecedented feat, as even Lassell, in 1864, secured ten measures of position-angle alone.

Mimas was, however, only once observed. The accidental error of a difference of right ascension between *Japetus* and *Saturn* from a single wire is only ±0.032^s; and Professor Hall hopes that, by varying the method of observing during the next opposition, possible constant errors may be eliminated. The number of observations of each satellite is as follows: *Japetus*, 70; *Titan*, 43; *Hyperion*, 40; *Rhea*, 31; *Dione*, 31; *Tethys*, 29; *Enceladus*, 16; *Mimas*, 1.

PROPER MOTIONS OF SOUTHERN STARS.

Mr. E. G. Stone, Her Majesty's astronomer at the Cape of Good Hope, communicates to the Royal Astronomical Society a paper on the proper motions of 406 southern stars, which is printed in the *Memoirs*, vol. xlii., p. 129. After examination, Stone concludes that those of Lacaille's 9766 stars observed at the Cape of Good Hope in 1751–2 with the *altitude* instruments are available for this purpose, but the places given by the *rhomboidal micrometer* are not sufficiently accurate.

Of the first class there are 398, but 130 of these are identical with Bradley's stars, so that the material for accurate determinations of proper motions in the Southern hemisphere is less than might have been expected.

Stone bases his determinations on Brisbane (1825) [for N.P.D. only]; Fallows (1830); Johnson (1835); Henderson (1833); and a MS. reduction of Maclear (1840). The separate results from each catalogue are exhibited.

ORBIT OF THE BINARY STAR γ CORONÆ AUSTRALIS.

The orbit of this star, which is in R. A. 18h. 55m., and south declination 37° 18′, was investigated by Captain Jacob in 1855 (*Mon. Not. R. A. S.*, vol. xv., p. 208), his orbit being based on twenty-one years of observation. Schiaparelli has lately reinvestigated this orbit, and he finds that Jacob's orbit does not accurately represent the later observations. Accordingly he has deduced the elements which best satisfy the whole series (allowing, however, more weight to the observations since 1852), and finds the period of revolution to be 55.582 years, and the semi-major axis to be 2.400″. Schiaparelli's elements agree very closely with observation, and he adds an ephemeris extending to 1882.—38 *C*, No. 2073, 133.

ORBIT OF THE BINARY STAR 70 (p) OPHIUCHI.

Since the first measure of position of this star by Sir William Herschel in 1779, over two hundred separate observations have been made, which under ordinary circumstances would be sufficient to yield an accurate determination of the orbit. Sir John Herschel, Bessel, Mädler, and others have successively determined orbits for this binary, in no one of which has a satisfactory agreement of theory with observation been maintained over a considerable length of time. Tisserand, of Toulouse (aided by Perrotin of the same observatory), has given this orbit a thorough investigation, and he finds that the conditions of the problem are such that a partial indetermination exists in one of the elements. Therefore he has solved the equations of condition involving the elements, leaving one element undetermined; and he shows that, if the angles of position of this pair can be measured in 1885 so as to leave an error of not more than ±0.2°, the doubtful element can be determined with at least five times the exactness it now has. His complete work will be published in the *Memoirs of the Royal Academy of Toulouse* for 1876.—6 *B*, *January* 24, 1876.

THE DOUBLE STAR BETA LEPORIS.

This star is of the 3.5 magnitude, and was discovered to be attended by a small (eleventh magnitude) companion by Mr. S. W. Burnham, of Chicago, on December 14, 1874. On that date Mr. Burnham estimated the distance of the companion to be about 2 to 3 seconds of arc, the position-angle from two measures being 269.1°. Further measures have been made by Dembowski, of Milan, and Hall, of Washington, as below:

1874, December 14..	$S=2''$ to $3''$;	$p=269.1°$—	Burnham.
1875.077	= .... ;	=268.4°—	Dembowski.
1875.112	= $2.89''$;	=267.1°—	“
1876.068	= $2.71''$;	=279.9°—	“
1876, January 31	= $3.16''$;	=280.4°—	Hall.
1876, February 17	= .... ;	=283.6°—	“
1876, February 18	= $3.08''$;	=279.0°—	“

From these independent measures it appears that there has been a change of position-angle of no less than 10 degrees in a little more than two years, which is a very rapid motion. This star may turn out to be an extremely interesting binary, and deserves the attention of all observers of double stars.

ON A CLASSIFICATION OF DOUBLE STARS.

Flammarion states that, in a general revision of double stars, he has divided them into classes, which have nothing in common with those of Herschel and Struve. These latter founded their distinctions upon apparent relative distances and magnitudes, whereas Flammarion has founded his classes upon the physical peculiarities of the different systems. He gives the name of *stellar systems* only to those of which 61 Cygni is the type, whose components, although physically associated and animated by a considerable common proper motion, do not revolve about each other, but move in straight lines. The name of *perspective groups* he gives to the double stars whose relative motions are in straight lines, but whose components are not physically associated, but are accidentally placed upon the same visual ray; one of which stars, therefore, is passing between us and the other by reason of a difference in their proper motions. Such double stars are far more numerous than the stellar systems, but less numerous than those whose components have remained relatively fixed since the time of their discovery. Of the stars belonging to the perspective group, an excellent example is found in Vega or Alpha Lyræ.—6 *B*, LXXX., 662.

ON THE DOUBLE STAR 61 CYGNI.

The observations made by Bessel in his work on the parallax of the star 61 Cygni led him to the conclusion that this double star was moving with great velocity, and that the two components were held together by the force of attraction, and were describing orbits about a common centre of gravity, the time of revolution being estimated at about 400 years, and the annual parallax at less than one half a second. The more recent observations of astronomers have, however, led Flammarion to conclude that no orbit as yet computed for this star will satisfy the observations, and that we are forced to conclude that the smaller of the two stars is moving with respect to the greater one in a perfectly straight line. That they are intimately connected, however, there can be no doubt. The question is as to the nature of their orbits; and, with respect to this, Flammarion states emphatically that they do not revolve about each other. Is such a conclusion contrary to the law of universal gravity? At first sight it would seem to be so; and we may have therefore in these stars an exceptional case, instead of that powerful proof of universal gravity which was formerly supposed. But as, theoretically, it seems unwise to doubt the universality of this law, we are led to conclude that the two components of 61 Cygni form, in fact, possibly only a double companion to a more distant principal star, unless, indeed, one of them is at a great distance directly behind the other. The latter conclusion is favored by Flammarion, who cites several very similar cases of large proper motions in relative right lines.—6 *B*, LXXX., 171.

THEORY OF PLANETARY PERTURBATIONS.

In the *Analyst* for November, 1875, Mr. George W. Hill, of Nyack, New York, published an interesting and important mathematical paper on the development of the perturbative function in periodic series. He states that of the two methods ordinarily employed for developing this function, in one the numerical values of the elements involved are employed from the outset, and the results obtained belong only to the special case that is thus treated. In the other method all the elements are left indeterminate, and thus is obtained a literal development possessing as much generality as possible. It is with the latter method that his own investigations have to do, and his object has been to simplify as far as possible the formulæ that were published by Puiseux in Lionville's *Journal* for 1860, and those obtained by Bourget, as published by him in the same journal for 1873. He seeks to effect this object by the introduction of the Besselian functions. Mr. Hill's thorough acquaintance with the analytical treatment of the problem in hand gives to his little memoir of twenty pages a very high theoretical value, and renders it the most important mathematical paper that has appeared in the *Analyst* since the beginning of its publication; and the appearance of a few more memoirs of this stamp should, we think, render the permanency of that journal a matter of certainty. It gives us, indeed, great pleasure to add that, according to a recent editorial announcement of Mr. Hendricks, definite arrangements have been made for its continuance for at least one, and possibly several years.—*Analyst*, II., No. 12.

ON THE SPECTRA OF THE NEBULÆ.

Dr. T. Bredichin, Director of the Observatory of Moscow, has lately investigated the spectra of various nebulæ, mostly planetary. The following (the numbers being taken from Herschel's General Catalogue in the *Philosophical Transactions* for 1864) have almost the same spectrum of three lines, viz., G. C. 4964, 4628, 4234, 4447 (annular nebula in *Lyra*), 4390, 4510. Regarding the three bright lines in these different nebulæ as identically the same, Bredichin deduces from his measures what he calls the *mean spectrum* of planetary nebulæ of this class, and he finds it to consist of three lines, A, B, C, of the following wave-lengths:

A=5003.9 ± 1.2; B=4957 ± 1.4; C=4859 ± 3.1.

A and B, as Bredichin remarks, are nearly coincident with the strongest rays of *iron* (5005 and 4956.5) in the bluish-green portion of the spectrum.

The nebula 4244 gives a *stellar* spectrum; the spectra of G. C. 4532 (Dumb-bell), 4373, and 4572 are described. Bredichin speaks of a star in the centre of the disk of 4373, but it is worthy of note that neither Herschel nor Kaiser (who examined this nebula in 1839) describe this star. This deserves examination.—2 *G*, *Nov.*, 1875, 109.

ON PHYSICAL OBSERVATIONS OF THE PLANET JUPITER.

The physical changes that are seen to take place on the planet Jupiter have of late years attracted an increasing amount of attention by the possessors of large telescopes; and among these Bredichin, of Moscow, has published a series of eighteen photolithographs of the planet as observed by him in 1874. In making these he has employed a telescope of nearly ten inches' aperture, with a magnifying power of 250. He has distinguished six distinct regions, *a* and *f* being polar regions, *c* the equatorial, *b* and *d* the tropical, and *e* the region lying between the north tropical and north polar. The zone *b* seems always to have had a color, which has been described as being somewhat green and somewhat blue. A very similar color may be remarked in a thick block of ice. The mean breadth of the equatorial band, *c*, was 9.7″, varying, however, from 7.7″ up to 13″. Luminous spots were frequently distinguished by him here and there, surpassing in brilliancy all other portions of the planetary disk. The variations of the bands *b* and *c* are especially noted by him. —*Bullet. Soc. Imp. Naturalistes Moscow*, 1874, 185.

THE ATMOSPHERE OF VENUS.

Prof. Watson, of Ann Arbor, in an address to the French Academy of Sciences, giving an account of his observations of the transit of Venus at Pekin, stated that at the height of about fifty-five miles, or one seventieth of the diameter of Venus, the atmosphere of that planet was liable to cause optical disturbance, such as would prevent the determination of the exact time of the real contact of its limbs with the sun's limbs, and therefore interfere with the determination of the solar parallax.—12 *A*, XII., 446.

ON THE BRIGHTNESS OF THE SATELLITES OF JUPITER.

Flammarion has made a series of observations of the brightness of the satellites of Jupiter in 1874 and 1875, in which he had in view the especial determination of the relative brightness of each of these, and the determination of their own reflecting powers, as well as the decision whether their brightness is variable, and in what proportions.

Among his observations he cites some showing that there is an atmosphere about each satellite, and, again, that the intrinsic reflecting powers of these four moons is not the same, but varies for each. Thus the fourth satellite is often dull and hazy, and although larger than the first and second, it is generally not so bright. Its surface is also not so white as that of the other satellites. We may then conclude with certainty that its substance, or at least its exterior surface, has less reflective power than that of the other satellites. Its brightness, moreover, varies considerably, and with no definite periodicity, and without any relation to the position of the satellite in its orbit: it is therefore not to any permanent spots on its surface that it owes its changes, but rather to its own variable atmospheric phenomena. Its brightness varies between the sixth and tenth magnitudes. The dimensions of the four satellites (1, 2, 3, and 4) decrease in the order 3, 4, 1, and 2. The intrinsic brightness decreases in the order 1, 2, 3, and 4. The variability decreases in the order 4, 1, 2, and 3.—6 *B*, LXXXI., 145, 233.

METEORS OF AUGUST 10TH–11TH, 1875.

The August meteors were observed at Lisbon, in 1875, with the following results:

10^h–11^h, 43 meteors; 11^h–12^h, 96; 12^h–13^h, 241; 13^h–14^h, 331; 14^h–15^h, 385; 15^h–16^h, 131. Total, 1227 meteors in six hours, or an average of 205 meteors per hour.—22 *B*, 1875, No. 266.

SPECTRA OF THE GASES CONTAINED IN METEORITES.

Professor A. W. Wright, of Yale College, in 1875 examined spectroscopically the gases derived from the meteorite which fell in Iowa County, Iowa, February 12, 1875. This was of the ordinary stony kind, containing, according to an analysis by Professor J. L. Smith, 12.54 per cent. of nickeliferous iron, and it was investigated in order to determine whether the spectrum of the gases evolved from it by heat would afford any information respecting the recent theories connecting such meteorites with comets.

The spectrum obtained was chiefly that of the carbon compounds, and showed a very close resemblance to the spectra of several of the comets. It was stated at that time that the nature of their gaseous contents establishes a marked distinction between the stony meteorites and the iron meteorites. Professor Wright has lately taken up this investigation, with the view of making a more extended comparison of the gases from the two classes, and the results of his examination of several specimens of both classes justifies his former conclusions. All suitable precautions were taken in obtaining and preserving the gases, and portions of the Iowa meteorite were re-examined with the result of confirming previous conclusions.

Professor Wright is still engaged on this research, but he considers the evolution of such large volumes of carbon dioxide as characteristic of the stony meteorites, and the relation of these meteorites and their contained gases to the modern theory of comets is certainly of great interest.—4 *D*, *April*, 1876, 262, *and July*, 1875.

THE ATMOSPHERE OF VENUS.

Mr. H. C. Russell, government astronomer to New South Wales, in giving an account of the observations made by the various parties stationed there on the transit of Venus, goes into some detail on the subject of the observed halo about the planet Venus, and its possible explanation. Most of the observers state that for some minutes before the first internal contact the whole of the planet's outline could be seen, and three distinct phenomena appeared to be distinguishable: First, a broad ring of light, outside of the planet; second, a bright ring of light around that part of the planet projected on the sky; third, a band of light around the inner edge of the planet, or over its surface. No spots were seen on the planet. The first, or halo, seems to Mr. Russell not likely to be due to any atmosphere. It is a phenomenon, in fact, seen only by some observers and under special conditions. The second, or bright ring, is the most interesting physical feature observed; although at first it would seem to be due to an atmosphere somewhat similar to that of the earth, yet Mr. Russell thinks that a little consideration will show that it can not have such an origin. It is spoken of by all observers as very brilliant, and its actinic power was so great that, although it could appear only as a fine line in the photo-heliograph less than 0.002 of an inch in diameter, it yet had power to affect the chemicals in something less than the 0.004 part of a second. In other words, it was quite as powerful, even more so, than direct sunlight. Mr. Russell thinks that an envelope of some perfectly translucent substance, such as water, would alone suffice to account for all the observed facts.—*Trans. Roy. Soc. of New South Wales*, 1874, 111.

DIAMETERS OF THE INFERIOR PLANETS AS AFFECTED BY DIFFRACTION.

André, of the Observatory of Paris, has undertaken a research on the diameters of Venus and Mercury as affected by the phenomenon of instrumental diffraction, in connection with the observations of the transit of Venus in 1874, which is of great interest, as this phenomenon is manifest not only in such observations, but in all cases where a telescope is employed for determining the place of the centre of a body by means of observations on its border or limb. The values of the diameters of Venus and Mercury obtained micrometrically, under ordinary conditions, are always greater than those obtained during a transit, and differ the more according as the aperture of the telescope employed is greater or less. Thus, during the transit of 1874, Mouchez obtained, with an equatorial of eight inches' aperture, the diameter of Venus as 64.38″; the observations of Main, at Greenwich, using a telescope of six and a half inches, and Plummer, of Durham, with about six inches' aperture, gave a diameter of 64.73″. This result comes from the fact that the image of a luminous point given by a telescope is not a point, but a disk surrounded by rings alternately dark and bright, whose diameter diminishes with an increase of aperture. The *difference* of the diameters of Venus or Mercury, obtained by the same instrument during a transit, and under ordinary conditions, should be double, or nearly double, the diameter of the disk of a star (a point) given by that instrument, or at least a quantity of the same order. The observations of Tennant and Main on Venus, and Plummer and Main on Mercury, give 0.724″ and 0.602″ for this quantity, and theory based on measures of Dawes and Foucault gives for the same quantity 0.854″. The practical effect of this is that the observations of the transit of Venus should be reduced to what they would have been provided all the telescopes had the same aperture (in the equipment of the American parties this was provided for by making all the equatorials of the same aperture, viz., five inches), and for this purpose André seeks to determine what he calls *the equation of instrumental diffraction.* To show the effect of this, he gives the following observations of the first internal contact at St. Paul's Island during the transit of Venus in 1874:

Observer.	Aperture.	Uncorrected Time.	Time reduced (Aperture 4 inches).
Mouchez..........	8 inches.	19*h*. 39*m*. 2.5*s*.	19*h*. 38*m*. 48.3*s*.
Turquet..........	6 "	38 56.1	38 46.5
Velain............	2.5 "	38 31.0	38 48.0

—6 *B*, *January* 17, 1876, 205.

In a second memoir on the same subject, André describes experiments made in a dark room with a telescope of 0.10^m aperture (1.24^m focal length), which was diaphragmed down to 0.017^m. His observations were made on an illuminated slit in a plate of copper, which could be made to appear bright on a dark ground or dark on a bright ground. He also measured the distance between the borders of two such slits lighted from behind, and separated by about the width of each of them. In the first case the difference of the diameters *observed* was 15.82″ for an aperture of 0.017^m, and 6.16″ for one of 0.049^m, and this difference *calculated* was 15.68″ and 5.33″. [$O - C = +0.14''$, and $+0.83''$.] In the second case the differences between observation and calculation were $O - C - 0.78''$, $+ 0.39''$.

André mentions among the consequences of this law two of immediate importance in the reduction of the French observations: First, the differences of longitude determined by the transits of the moon's limbs (first and second) *may* vary by so much as 3.5^s of time, when the longitudes are determined by transit instruments of the size furnished to the French parties. Second, in the occultations observed at Greenwich, discussed by Breen, and used by Newcomb to determine the coefficient of parallactic inequality, a correction of + 1.1″ is applied to the lunar diameter, in order to take account of the increase of the moon's diameter by irradiation.

André is of opinion that this correction should not be applied, and that consequently Newcomb's value of the solar parallax from this datum (8.444″) should be diminished by 0.07″; and he expresses his belief that the results of the late transit of Venus will give a value of the solar parallax at least as trustworthy as those derived by other methods, provided a suitable selection of the best observations is made, that selection to be based on proper physical discussions.—6 *B*, 1876, *March* 13, 607.

AN ANCIENT DISCOVERY OF A VARIABLE STAR.

Beaudet calls the attention of the Academy of Sciences of Paris to the fact that among the rare pieces of apparatus in the collection of the Bureau of Arts and Machinery, there is a celestial globe dated 1622, constructed by W. J. Blaen, of Amsterdam. This geographer was originally a student of

Tycho Brahe, and subsequently devoted himself to the construction of globes, which he made in great perfection, of three different dimensions. His larger celestial globes, in a space near the constellation Cygnus, mention the discovery, in 1600, of a new star in the breast of the Swan. Kepler stated, in 1606, that this star had been discovered by Blaen himself; the date of the discovery was the 18th of August, 1600. At that time it was of the third magnitude. It soon after diminished until it became invisible to the naked eye, and only became visible again in 1670, when it again attained a third magnitude, lasting two years; but faded away, and has not since been observed. Possibly it will appear again about 1880.—6 *B*, LXXXI., 335.

THEORY OF THE SATELLITES OF JUPITER.

The present predictions in the Astronomical Ephemerides of the phenomena of Jupiter's satellites are based on the tables of Damoiseau, which extend only to 1880. The predictions of *eclipses* are in error, by the observations of Mr. D. P. Todd, at Amherst College, in 1875 (with a four-inch aperture), by the following amounts:

I.	Satellite;	Correction to Tables	$+ 53.0^s$	for a Disappearance;	16 obs.
II.	" ;	" " "	$+ 11.8^s$	" " ;	8 "
III.	" ;	" " "	$+ 24.1^s$	" " ;	4 "

M. Souillart has re-examined, in several memoirs published in *Annales Scientifiques de l'Ecole Normale Supérieure* (t. ii., 1. série), the theory of these satellites as delivered in the *Mécanique Céleste*, making use, however, of a different process from the one followed by Laplace. His results have in general confirmed the previous theory. New researches by M. Souillart lead to some important modifications in the values of Laplace's coefficients. These latest researches will soon be published with others, so as to furnish a complete theory of the motions of Jupiter's satellites, together with tables, now so much needed.—6 *B*, *March* 27, 1876, 728.

ON THE PARALLAX OF 1830 GROOMBRIDGE.

The star 1830 Groombridge, which is so famous on account of its extremely large proper motion, has for forty years been a favorite subject of measurement for the determination of its parallax. The most recent observations of this character are those by Professor Brunow, of Dublin, whose result, 0.097″, is of the highest apparent value. Previous to him, the other determinations that had been made were as follows: Otto Struve, 0.034; Wichmann, 0.114; Schluter, 0.166—or on the average, 0.118; which latter value, as given by Auwers, can not be suspected of a probable error greater than 0.02. These four values of the parallax are, strictly speaking, only relative parallaxes of the star in question, as compared with four smaller neighboring stars. In a highly instructive memoir by Auwers on the parallax of this star, he shows that, although the heliometer used by Johnson at Oxford in 1852 and 1853 was one of the finest in existence, and ought therefore to have yielded a result of great value, yet the results attained by him can not be considered worthy of comparison with those made by the four observers before mentioned, on account of defects in his method of observation. Johnson's observations are subjected by Auwers to analysis in the usual thorough manner of that able computer, an analysis facilitated by the fact that he has himself made a series of similar measurements with Bessel's heliometer at Königsberg. The best result that Auwers is able to deduce from Johnson's observations attributes to the star a parallax whose probable error is larger than the parallax itself, and that, too, without representing the original observations any better than the simple assumption of no parallax at all.—*Monatsbericht Acad. der Wissenschaften, Berlin*, 1874, 569.

MOVEMENT OF A PLANET IN A RESISTING MEDIUM.

Among the many problems relating to the planetary motions, that of the movements of a point under the influence of the force of gravitation and of a resisting medium offers always a high interest. This has been made the subject of the inaugural dissertation of Dr. Hermann Hohnhorst, who has considered the resistance of the medium to be proportional to its density, and to the square of the velocity of the moving body. The integration of the elementary differential equations is sought to be accomplished by him by the application of the theory of the variation of the arbitrary constants. By this means he is led to four equations, giving respectively the variations of the major axis, the eccentricity, the inclination, and the longitude at the initial time. The complete integration of these four equations is effected by him by the use of elliptic integrals and the so-called *theta* function.

THE URANIAN AND NEPTUNIAN SYSTEMS.

No sooner was the 26-inch refractor at Washington in working order than its powers were tested by an examination of the planets Uranus and Neptune, in order to ascertain how well the satellites of those planets were visible by its means. The two nearest satellites of Uranus had never been recognized as such by any astronomer until Lassell's telescope was mounted at Malta, nor again after that until they were observed at Washington. The results of the first year's observations of these satellites are now published in a memoir by Professor Simon Newcomb on the Uranian and Neptunian systems, accompanied by tables whereby the apparent positions of the satellites may in a few minutes be predicted with sufficient accuracy. Apart from the determination of the exact positions and movements of the satellites themselves, Professor Newcomb's memoir finds its highest interest in the fact that he deduces from these observations new determinations of the masses of the two principal planets. His results have an intrinsic accuracy far surpassing that of the very discordant results given by previous observers, and his long series of unprecedentedly exact observations (although the objects observed by him are justly considered the most difficult that offer themselves to the astronomer) is a fine testimony to the correctness of the principle adopted by him that, "in the present state of astronomy, it is better to do one thing well than many things indifferently."

Among the more important results, Professor Newcomb states that we are led to the remarkable conclusion that the eccentricities of the satellites of the two outer planets are insensible so far as they can be determined from all the observations hitherto made on them, and that in the case of Oberon and Titania the orbits are more nearly circular than in the case of any of the large planets of our system. The most probable value of the mass of Uranus is, he concludes, $\frac{1}{22600}$, with a probable error of 100 in the denominator. For Neptune, Professor Newcomb finds that the mass is $\frac{1}{19380}$, with a probable error of 70 in the denominator. He adds that he can say with considerable certainty that there is no satellite within two minutes of the planet Uranus, outside of Oberon.—*Appendix I. to the Washington Observations for* 1873.

OBSERVATIONS ON THE ZODIACAL LIGHT.

In the volume of observations on the zodiacal light, published by Heis, he gives a slight historical sketch of the observations of that phenomenon, from which it appears that his own observations were begun by him at Aix-la-Chapelle in 1847, and continued by him there until 1852, since which time they have been pursued at his residence at Münster. In 1864 Weber, at Peckeloh, began to assist him. In 1843 to 1845 Schmidt, of Athens, and in 1853 to 1856 Rev. George Jones, of the United States, observed the zodiacal light. A large number of other observers are mentioned by him, from whose observations he has drawn liberally in compiling such notes as he has thought appropriate. The total number of zodiacal-light observations given by him is thirty-four, most of them observed very fully by at least one person, and oftentimes by two. Some of the records are much fuller than others, but in all sufficient is given to find the exact place of the light, its limits, its apex, and axis.—*Zodiacal Light Observations by Edward Heis, Münster*, 1875.

THE COMET III., 1862.

This comet threw out in the neighborhood of the sun a second and supplementary tail, which was carefully observed by Schiaparelli at Milan (*Pub. dei R. Oss.*, etc., ii., p. 21). Bredichin, of Moscow, has discussed these observations on the supposition that this tail was in the plane of the orbit, and he computes for each observation the angle of the tail and the radius vector, the length of the tail, etc. The values of these quantities show that the tail preceded the radius vector in its motion through space, and that the force which was necessary to the formation of the tail was in terms of the force of gravitation (= 1) 1.013. Supposing this force to be 1.000, Bredichin computes the velocity of the luminous jets for this comet, and finds it to be equal to 0.02; for Halley's comet Bessel found this velocity 0.04; for the comet of 1858 this was 0.14; for the comet of 1811 it was 0.17.

Dr. Bredichin will shortly publish a complete discussion of this interesting subject.—38 *G*, LXXXVII., 239.

ORBIT OF COMET II., 1840.

This comet was discovered by Galle, of Berlin, January 25, 1840, and was observed until the end of March. Dr. Kowalczyk, of Warsaw, has recently reinvestigated its orbit from a good number of observations, and finds it to be an ellipse, the periodic time being 3789 years. The agreement of observation with his theory is very close. Plantamour and Loomis had previously investigated this orbit, and their results may be found in *Astronomische Nachrichten*, No. 476, and *Transactions of the American Academy of Arts and Sciences*, vol. viii. Plantamour's orbit was parabolic, and represented the Geneva observations well; Loomis's was an ellipse, which corresponded to a periodic time of 2420 years; Kowalczyk's, however, agrees so well with all the observations that this orbit may be considered as settled. —38 *C*, LXXXVII., 225; 12 *A*, *March* 16, 1876, 386.

ON THE CALCULATION OF THE ABSOLUTE PERTURBATIONS OF COMETS.

Professor H. Gyldèn, Director of the Astronomical Observatory at Stockholm, communicates to the Paris Academy of Sciences a method of calculating the absolute perturbations of comets. He states that in all cases where the solution of the problem of these bodies can possibly be effected by developing the expression for the perturbing forces into a series depending upon their powers and products, the principal difficulty is experienced in the evaluation of two consecutive quadratures, the first of which is ordinarily performed by means of a series depending upon the sines and cosines of the eccentric anomaly. This method, however, becomes inapplicable in the case of comets whose orbits are ordinarily very eccentric. In order to meet this case, Hansen has invented the method of partitions, in which he divides the comet's orbit into successive portions, and introduces into them new variables called partial anomalies; the variables for one partition being connected with those of the next by a discontinuous function. Professor Gyldèn's method consists in modifying that of Hansen, by introducing an elliptic integral in place of the discontinuous variable, by means of which, it is said, he is able to compute the perturbations with ease, even in the most difficult cases.—6 *B*, LXXX., 808, 907, 1070.

SPECTRUM OF COGGIA'S COMET.

Some accurate observations of the spectrum of Coggia's comet of 1874 were made by Bredichin, of Moscow. The greater part of his work was done by means of a spectroscope by Merz. The values of the scales used by him were determined each night by comparison with a Geissler's tube. The channels observed in the cometary spectrum coincide with those of the bands in the spectrum of the hydrocarbons, whose wave lengths are respectively 563.3, 516.4, and 474.2. —*Bullet. de la Soc. Imp. des Naturalistes de Moscou*, 1874, 146.

THE PERIODIC COMET OF D'ARREST.

The periodic comet of D'Arrest was discovered in 1851 by that astronomer. Its orbit about the sun was computed with considerable precision by Villarceau, who allowed for some of the perturbations to which it was subjected by the attractions of the planets. His work has been recently taken up by Le Veau, and carried to a considerable degree of refinement; the inclination of the plane of the comet's orbit to the plane of the ecliptic is only fourteen degrees. A special difficulty, however, arose from the fact that in 1861 the comet approached very near to the planet Jupiter, and the influence of this great body was so considerable that the variations in the perturbations were sensibly of the same order as the changes in the elements of the comet's orbit, so that, in order to obtain the corrections to the latter, the ordinary equations of condition would not suffice. This difficulty was overcome by employing the method of false position. The twenty-two resulting equations were resolved by the method of Cauchy. The mass of Jupiter employed in these computations is that deduced by Bessel from observations of the satellites of that planet; and the results of Le Veau's observations show that no material change in the mass of Jupiter is needed, although the new observations of this comet at its successive apparitions will probably enable the astronomer to determine the mass of that planet with very great exactness.—6 *B*, LXXXI., 141.

THE LUNAR THEORY.

The theory of the movements of the moon, which has occupied so many astronomers since the days of Laplace, or, more correctly speaking, since the days of the earliest Chaldean observers, has most recently received some additions by the labors of Schjellerup, who has paid especial attention to the acceleration of the moon's mean motion, and the identification of the eclipses that are recorded by the ancient astronomers. Schjellerup has especially sought for confirmation of his investigations by computing the eclipses recorded in the Chinese classics, as published by Dr. Leggie. Among the eclipses subjected by him to computation are those which occurred 708 years B.C., 600 years B.C., and 548 years B.C. —*Oversigt Kongelige Danske vid. Selsk.*, 1874, 61.

ASTRONOMICAL OBSERVATIONS AT MANNHEIM.

In the volume of astronomical observations at Mannheim, recently published by Schönfeld, he gives the observations of nebulæ and stellar clusters that have been made by him since 1862, amounting in all to eight hundred and twenty complete measurements of the distances between nebulæ and neighboring stars. His object has been to determine the positions of as many nebulæ as possible, as accurately as he could by measuring micrometrically their distances from neighboring stars. In this work, in which he was almost the only observer twenty years ago, others have also become active since then, and have even surpassed him in the quantity of work done, though not in quality.

The condition of the atmosphere has been carefully noted by him at each observation. The constant differences between his own positions and those of other observers, such as Schultz, are very small.—*Astron. Beob. auf der Grossen Sternwarte zu Mannheim, Dr. E. Schönfeld*, 2. Abth., 1875.

ASTRONOMICAL OBSERVATIONS AT MILAN.

The recent publication No. 5, from the Royal Observatory at Milan, contains various astronomical observations, among which are especially prominent the photographic plates representing Coggia's comet of 1874, a chart of the Pleiades, and a lithographic plate representing the phenomena of the lunar eclipse of the 1st of July, 1863. In the latter the varied colorings of the portions of the disk of the moon are very striking. In the chart of the Pleiades, the nebula around Merope is represented as very distinct. There seems to be good reason to doubt the variability of this object. The series of drawings of the comet of 1874 appears to be remarkably complete, and is very skillfully executed.

THE GREAT PARIS TELESCOPE.

The great telescope at Paris is now quite complete, except in a few minor matters. It was officially exhibited on the 7th and 9th of October. The mirror is 47 inches in diameter, with a focal distance of 23 feet. The weight of the mirror is half a ton; it is constructed of glass, and is silvered by the Foucault process. A metallic mirror of the same size would probably weigh four tons. The cost of the mirror was £2000. The telescope is mounted like an ordinary equatorial refractor. A magnifying power of 500 has been found to answer excellently for observing minute stars. The finder, together with the ocular and the small plane mirror, are all placed at the front of the tube, and can be rotated around its axis, thus facilitating the use of the large iron winding staircase from which observations may be made. The height of this staircase is about 40 feet, and its weight six tons. It rests on two circular iron rollers, and is always placed on the same side of the tube as the counterpoise. It is moved by special machinery. The observations are made in the open air, but the instrument is protected at other times by means of an iron house, which building weighs twelve tons, and is movable on rollers by means of special machinery, so that it can be rolled to one side, and in less than a quarter of an hour the huge telescope can be uncovered and pointed upon any object, however minute. The entire cost of the telescope and appurtenances has been £8000, and it has occupied six years in building, the work having been interrupted several times by the events of the civil war and other matters; its final accomplishment is due to Le Verrier's perseverance. This distinguished astronomer now contemplates undertaking a large refractor, having a focal length of about 55 feet. Its construction will probably occupy three years. The appropriation initiating this new work has already been made.—12 *A*, XII., 538.

LARGE TELESCOPES.

It is announced that the principal refractor of the new observatory at Vienna is to be manufactured by Grubb, of Dublin, the order for its execution having already been given. The object-glass will have an aperture of about 27 inches, according as the disks of glass turn out, these latter being manufactured in Paris. The axes will all have their friction relieved by anti-friction apparatus. The tube will be entirely of steel; and all the various motions of the instrument, as well as the readings of the different circles, will be available to the observer from the eye end. The telescope will be mounted completely at Mr. Grubb's new workshops, and covered by a corrugated iron roof fifty feet high. The latter is but a temporary structure; outside of it will be erected a splendid steel dome originally designed by Mr. Grubb, which, after being tested at Dublin, is to become in Vienna the permanent shelter of the mounted refractor.—12 *A*, XII., 517.

THE SPECTROSCOPIC OBSERVATORY AT CALCUTTA.

Rev. E. Lafont, Rector of St. Xavier's College at Calcutta, has addressed the President of the Asiatic Society of Bengal a letter in which he says he proposes to erect a spectroscopic observatory at the college, where daily observations and maps of the solar protuberances will be made. As this undertaking is entirely for the benefit of science, he ventures to request such assistance and subscriptions as may be necessary. The total sum required is about ten thousand reals, toward which the council of the society has contributed five hundred. He states that the pressing invitation of his friend, Professor Tacchini, first induced him to attempt the establishment of a spectroscopic observatory.—*Proceedings of the Asiatic Society of Bengal, February*, 1875.

THE SOLAR ATMOSPHERE AND RADIATED HEAT.

Mr. John Ericsson has published a portion of his solar investigations in a special memoir (privately printed in New

York), in which he gives the results of his investigations into the difference of intensity of heat transmitted from different parts of the sun's surface. His instrument has a focal length of fifty-eight feet, being a telescopic tube of that length, within which diaphragms may be placed so as to expose to view only definite small portions of the solar disk. By means of three actinometers which record simultaneously the rays of heat received—first, from the entire area of the solar disk, second from a central region, third from a zone at the border—he is able to arrive at the desired comparison. In order to insure greater exactness, he surrounds his three actinometers with wooden jackets through which a steady stream of water is circulated, thereby keeping the chambers at a uniform temperature. He concludes that the radiation at the edge of the solar disk is but two thirds of that at the centre, while the total absorption of the solar atmosphere is about one seventh of the radiation emanating from the photosphere.—*Ericsson's Solar Investigations, New York*, 1876.

DISTRIBUTION OF STANDARD TIME IN SWITZERLAND.

The report of Professor Hirsch, Director of the Observatory of the canton of Neuchatel, in Switzerland, gives an account of the methods adopted at Neuchatel for distributing accurate time throughout the neighboring country. He says the importance of telegraphic transmission of astronomical time for the development of accurate horology is fully appreciated both in Neuchatel and the neighboring cantons. Gradually the system of transmission of time has been extended so as to embrace even the canton of Vaud; and, among other cities, those of Neuchatel, Geneva, St. Croix, Locle, and numerous other stations. In accordance with a formal agreement between the canton of Vaud and the canton of Neuchatel, the government of the former pays an annual sum toward the support of the Neuchatel Observatory; the organization of the whole service being left with the observatory, but the local expenses of receiving time signals are charged to the government of the canton of Vaud. It would seem, however, that the organization of the astronomical and telegraphic work has not yet reached the perfection which it has attained in England, since it is reported since last year that the signal at one station has ceased altogether, while at another it was received only 74 times. At Locle the signal was missed 128 times, and at Chaux-de-fonds it was missed 92 times in the course of the year. These imperfections are attributed directly to the want of proper telegraphic facilities; and the experience of fifteen years has shown the force of the recommendation of the director of the observatory, who urges that he should have under his control a special telegraphic wire for the use of the observatory, at least during certain hours of the day. The testing of chronometers is undertaken by the observatory at Neuchatel on a very large scale for the benefit of the chronometer-makers of Switzerland. The total number tested being 239 during the year. The mean average daily variation of the marine chronometers has been 0.02 of a second of time. First-class pocket chronometers, 0.44 of a second; second-class pocket chronometers 0.55 of a second; and, in general, only five per cent. of the chronometers show a mean variation exceeding half a second. It is reported that the anchor escapement steadily acquires favor both among manufacturers and the public. The chronometers having a Breguet flat spiral hair-spring show a superiority over all the others, except those having Phillips's flat spiral, or double curvature. Although the number of marine chronometers is very small, yet they have shown a remarkable excellence, especially the one presented for testing by Henry Grandjean, of Locle, which stands at the head of the list for the perfection of its temperature compensation.—*Bulletin Soc. des Sciences Naturelles, Neuchatel*, 1875, X.

EGYPTIAN CHRONOLOGY.

South communicates to the Academy of Sciences at Munich an exhaustive memoir on the Sothis or Sirius period of the old Egyptians. He intends his memoir on Egyptian chronology as complementary to that on Egyptian history which he published some five years ago. From his complete review of the subject we note that he concludes that the fifty-second year of Sesostris coincides with the Phœnix epoch, or 1525 years B.C.; and the eighth year of Rameses III. coincides with the Sothis epoch, or 1325 B.C. And he therefore finds no reason for changing materially the traditional exodus of the Hebrews, usually put at 1490 B.C., in which he differs somewhat from Lepsius, who places the exodus under the reign of Menoptah, about 1314 B.C.—*Sitzb. Acad. der Wissenschaften, Munich*, 1874, 84.

LIST OF LOGARITHMIC TABLES.

In the last volume of the memoirs of the Royal Academy of Sciences of Amsterdam, Biereus de Haan gives a list of published tables of logarithms, in continuation of a similar list published by him in 1862. The latter contained 267 titles; the present list, however, contains 553. Of these, 57 were published in the Netherlands, 144 in England, 178 in Germany, 91 in France, 23 in Italy, 22 in Denmark, Sweden, and Norway; 9 in Spain and Portugal, 9 in North America, and others elsewhere: 47 of these were published between 1614 and 1649, inclusive; 51 from 1650 to 1699; 48 from 1700 to 1749; 73 from 1750 to 1799; 199 between 1800 and 1849. While most of the tables give the logarithms to 4, 5, 6, or 7 places, 13 give them to 10 places. One table gives 50 places; four give 60 or 70 places, and one gives 102 places. This latter was published in 1871 at New York as a duodecimo, under the title of "Astronomical Tables," by H. M. Parkhurst.—*Verhand. Kön. Akad. Wetenschappen, Amsterdam*, 1875, XV.

CALCULATING MACHINES.

Mr. George B. Grant, while a student of the Lawrence Scientific School, invented a new and simple form of calculating machine, which is now on exhibition in Machinery Hall, Philadelphia. Two styles are now made, the first being for special use, while the second is intended for use in counting-houses, insurance offices, etc.

THE DIFFERENCE ENGINE.—This is a large machine built for the University of Pennsylvania, and designed for the construction of large mathematical tables, such as tables of logarithms, sines, tangents, reciprocals, square and cube roots, etc. It computes the terms of any such table, and prepares a mould of them stamped in wax, from which an electrotyped plate is made, ready for the press. It stands five feet in height by eight in length, weighs 2000 lbs., contains, when in full working order, some 15,000 pieces, and is worth about $10,000.

THE CALCULATING MACHINE is a smaller instrument for common operations in multiplication, division, etc. It is a foot in length by half as much in height and width, weighs twenty pounds, and contains less than 400 pieces, less than 75 of which are working parts. It takes numbers up to nine decimal places. Its mechanism is simple, strong, and durable; its manipulation is easy.

SPECIAL TREATISE ON DOUBLE STARS.

A work is now preparing in England which will be of importance to all observers of double stars, and to those interested in the calculation of the orbits of binary stars. Its joint authors are Mr. Gledhill, Mr. Crossley, and Mr. Wilson of England, all expert double-star observers, and Dr. Doberck, of Markree, Ireland, to whom we owe the investigation of many orbits of binary stars.

Mr. Gledhill is to write on the observations of double stars, binary star-orbits, and the history of the subject; Mr. Crossley describes the various micrometers and their use, etc.; Mr. Wilson gives an account of the various graphical methods of calculating orbits of binaries; and Dr. Doberck treats of the analytical investigation of such orbits, with examples chosen from his researches on *Sigma* and *Gamma Coronæ*.

THE CORONAL-LINE 1474 K.

The line 1474 of Kirchoff's scale, which is reversed in the spectrum of the solar corona, is known to nearly coincide with one of the short lines in the iron spectrum when the Leyden-jar spark is used (not with the electric arc between carbon points). Even with powerful spectroscopes it appears in the solar spectrum as a fine, hard, black line. Professor Young, of Dartmouth College (the discoverer of the line in the solar corona), has examined and mapped the neighborhood of this line in the diffraction spectrum produced by reflection from gratings ruled by Mr. L. M. Rutherfurd; and he finds this line to be unmistakably double. The two components are separated by a distance of about $\frac{1}{7}$ of a division of Angström's scale, i. e. about $\frac{1}{40}$ of the distance of the D lines. The more refrangible component (which Young considers to be the coronal-line) is heavier and more hazy than the other, which is well defined. Three gratings (6480, 8640, and 17,280 to the inch respectively) have been used, and the observations have been most easily made in the 8th order spectrum in the second of these, or in the 5th order with the third.

The spectra are viewed by reflection from the surface of the grating, and to separate the spectra of the higher orders a 45° prism is placed between the grating and the observing telescope. By this ingenious process these spectra are separated, the red of the 6th order spectrum falling below the yellow of the 7th, and this underneath the green of the 8th; while above this green lies the blue of the 9th order, and above that the extreme violet of the 10th.

This separation may be effected by the direct-vision prism of the observing telescope, but less perfectly.—4 *D*, *June*, 1876, 429.

THE THIRD RADCLIFFE CATALOGUE OF STARS.

We learn from the report for 1876 of the Rev. Robert Main, Radcliffe observer at Oxford, that the preliminary work for the compilation of the Third Radcliffe Catalogue has been begun. It will contain about 4000 stars, the result of nine years' (1862–1870 inclusive) observations. Particular attention has been given to those stars of the British Association Catalogue whose positions are imperfectly determined.

For the year June, 1875, to June, 1876, there were observed 2303 transits and 3471 zenith distances of 1187 stars. The sun was observed on the meridian 100 times, the moon 51 times, *Mercury* 34 times, *Venus* 17 times, *Mars* 5 times, *Jupiter* 24 times, *Saturn* 14 times, *Uranus* 5 times, and *Neptune* twice.

LUNAR MAPS.

Besides the well-known map of Beer and Mädler, there have been several attempts to portray the features of the moon's surface. Of these no one is probably more accurate than that of Lohrmann, a portion of which was published in fine steel engraving in 1824. Barth, of Leipzig, is now publishing the remainder of this map, which will be three feet in diameter. A descriptive letter-press is to be furnished by Schmidt, of Athens. At the same time Schmidt is editing his own work, which will be embodied in a map six French feet in diameter, which the Prussian government has purchased. This last is the result of thirty-four years' work, and contains about 34,000 craters and an equal number of hills, besides other objects. It is to be explained by a suitable text. Work upon Birt's map, formerly prosecuted by aid of the British Association's funds, is for the present suspended. It is to be hoped that this may one day be completed. —12 *A*, *May* 18, 1876.

SUPPOSED OBSERVATION OF AN INTER-MERCURIAL PLANET.

M. Weber, of Peckeloh, observed on the 4th of April, 1876, about 4^h, a round spot on the sun which was not there on the morning of that day, and which had disappeared on the morning of the 5th. It is somewhat curious, as pointed out by Dr. Wolf, of Zurich, who communicates the observation to Le Verrier, that this observation is 6219 days$=148\times42.02$ days after that of Lescarbault, as 42 days seems to be the period indicated by former observations (?) of this supposititious planet. Thus the observations of Steinhübel (1820), Pons (1823), Stark (1826), Capocci (1845), Schmidt (1847), Ohrt (1857), and Lescarbault (1859), seem to indicate a period of 42 days, the separate results ranging from 42.07 to 41.95. From Lescarbault's observation alone Le Verrier deduced a period of about 19 days.—6 *B*, *Aug.* 28, 1876, 510.

GLASS DIVIDED CIRCLES FOR THE MEASUREMENT OF ANGLES.

Mr. Lewis M. Rutherfurd publishes in the *American Journal of Science* for August, 1876, an account of a circle divided on glass which he has had fitted to his spectrometer. It is ten inches in diameter, divided to ten minutes of arc, and read by two microscopes magnifying seventy-five diameters to single seconds. A second on such a circle is about one forty-thousandth of an inch, but such was the fineness of the lines of division that the probable accidental error of pointing was considerably less than half a second of arc. Mr. Rutherfurd is of the opinion that on glass circles so divided and of fifteen inches in diameter, more accurate work could be done than upon the metal circles (thirty-six inches and upward in diameter) now in use in large astronomical instruments. "The advantages of this system are obvious: perfection of surface, permitting a line of any desired fineness; facility of illumination, permitting the extension of the power of the reading microscopes to several hundred times; smallness of dimensions, and consequent cheapness; and avoidance of almost all the questions of flexure and local effects of temperature."

CINCINNATI CATALOGUE OF NEW DOUBLE STARS.

The Cincinnati Observatory has just published in a neat octavo form a catalogue of fifty new double stars, discovered with the 11-inch refractor, by H. A. Howe, with the places of the stars for 1880.0. The pages are well arranged, every thing relating to the *position* of the star being on the left-hand page, and the *position-angle*, *distance*, and *magnitudes* of the doubles, with the date of discovery and remarks, being opposite, on the right-hand page.

The stars are mostly small, and all are below the sixth magnitude; but, on the other hand, the pairs are close, no less than twenty-one out of the fifty pairs being two seconds of arc or less in distance, and none greater than eight seconds. Most of them are also very far south, in a field comparatively unworked before.

LIST OF LATITUDE STARS EMPLOYED IN THE COAST SURVEY.

It has heretofore been the custom in the Coast Survey to determine the latitudes of the various astronomical stations by means of pairs of stars selected from the catalogue of the British Association, for observation by Talcott's method. These pairs were observed in the field, and the note-books sent to Washington, where the final reductions were made. The declinations for the observed stars were obtained from a comparison of good modern authorities, such as the publications of the observatories of Greenwich, Washington, Radcliffe, and Armagh. In many cases the observatories of Washington and of Cambridge, Mass., have determined the declinations specially. The Coast Survey has selected from the "Durchmusterung" all stars between the declinations of +88° 40′ and −1° 48′, and above the 5.9 magnitude, 2164 in all, and has published in its report for 1873 a list of these, with the approximate places for 1880.0.

It is further intended to publish shortly accurate places of all these stars, so that a complete working catalogue of nearly all the naked-eye stars of the northern hemisphere will be available. The list was selected under the direction of Assistant C. S. Peirce, who has also given much attention to the determination of the magnitudes. This list has been carefully compared with the catalogue of Heis, with the result of detecting a very large number of errata, a list of which forms a supplement to the catalogue of great value. The catalogue has seven columns: 1. The current number from 1 to 2164; 2. The number in the B. A. C.; 3. The usual designation by constellations; 4. The magnitudes as assigned by Mr. Peirce; 5 and 6. The approximate R. A. and δ for 1880.0; and 7. Synonyms and references to other authorities than the B. A. C.

SPECTRUM OBSERVATIONS OF THE STARS.

M. D'Arrest, the Director of the Observatory at Copenhagen, writes that he continues to devote the powers of his large telescope to celestial spectroscopy. His "Durchmusterung," or spectroscopic examination of the stars in the northern heavens, continues to increase the number of stellar spectra which belong to the third class in a far larger proportion than any other of Secchi's four divisions. The stars of this type afford remarkable objects for investigation, and are pretty numerously and uniformly distributed throughout the heavens. Only a few other spectra have striking similarities among themselves. In some the position and the groups of dark absorption bands are, as Secchi and Vogel have stated, in complete accordance. Groups occur in which even the various intensities of the bright lines are sometimes alike; these lines being, in general, brightest near the red end, although frequently exhibiting uniform brightness throughout the spectrum. But there is a remarkable uniformity in all the spectra. Out of 11,000 stars whose light has been thus examined, only eighty spectra offer characteristics worthy of special mention, and only five new stars are found whose spectra belong to the fourth class. On the average, therefore, where there is one star of the third class for every 140 stars examined, there is but one star of the fourth class for every 1000; and this holds throughout for all stars brighter than the eighth magnitude. In bright stars of the third type, dark absorption bands have several times been perceived. Only once, says D'Arrest, has he found a star of the sixth magnitude with distinct bands, departing in this respect from the characteristics of both the third and the fourth types, in which case, however, a short examination revealed to him that he was examining the planet Uranus, and not a fixed star. Twice in the course of his sweeps among the stars has he thus, with his small instrument, spectroscopically discovered this planet.—*Astr. Nach.*, LXXXV., 250.

THE RESISTING MEDIUM EXISTING IN SPACE.

The argument for the existence of a medium in the interstellar spaces which is sufficiently dense to affect the movements of the planets, comets, etc., has for a long time been based solely upon the supposed retardation of the movements of Encke's comet. This body completes its orbit around the sun in about three years, but has of late always appeared so exceedingly faint as to be invisible except in the most powerful telescopes. The accurate computations of Von Asten having shown him that the movements of this body, as observed during the last ten years, could be accurately accounted for by a careful computation of the disturbing attractions of the planets, he was led to predict the positions in which the comet should appear during the spring of 1875, in which predictions no allowance was made for the resistance offered to its motion by Encke's hypothetical ethereal medium. The first glimpse of the comet during that season was obtained by the observers at Washington in charge of the great equatorial. According to these and other astronomers, the comet passed in the heavens through a path so nearly accordant with Von Asten's predictions as to show that to account for its motion during the last two or three apparitions no recourse to the notion of a resisting medium is necessary. Further investigations on this comet are in progress.—7 *C*, XI., 45.

MOTION OF THE SOLAR SYSTEM IN SPACE.

In a recent contribution to the study of the motion of the solar system in space, Professor Safford, of Chicago, states that his investigation is based upon the movements of the 250 stars examined by Argelander, for nearly all of which we have very accurate determinations of the proper motions, while only six or seven of them have been previously used in the similar investigations of Argelander, Mädler, O. Struve, Airy, Main, and others. In studying these stars, Professor Safford states that he grouped them by tens, assuming those to be equally distant whose proper motions in arc were nearly equal, and therefore leaving entirely out of consideration the brightness of the stars. His first result, as regards the direction of the movement of the solar system, was not very different from those of his predecessors; but there appeared indications that, for each of his groups of stars, the average proper motion was inversely proportioned to the average distance; in other words, that our assumption of stellar distances ought to depend upon proper motions. He concludes that the stars having similar motions especially need study at this time, and that eventually we may hope to use the solar motion as a sort of base to advance our knowledge of stellar distances. This will be accomplished so soon as we know the values of all the parallaxes that amount to or exceed one second; and this may be soon determined by systematic co-operative arrangements among the astronomers of the world.—*Proc. Am. Acad. Arts and Sci.*, 1875, 82.

EXACT OBSERVATIONS OF NEBULÆ.

Dr. Schultz, of Upsala, has during the past ten years devoted a great deal of attention to the observation of nebulæ, having special reference to the determination of their precise positions and motions. The results of his observations have been published as a catalogue of 500 nebulæ, the whole number of single measures amounting to 12,000, a number which is large enough to assure us of his great devotion to the work. The heavens at Upsala are rarely free from clouds for any length of time; and the long twilights of summer, the regular recurrence of bright moonlights, and the frequent brilliant auroræ, have all combined to leave him but 404 working nights (or one night in ten in the course of eleven years) that could be utilized for his delicate measurements. The large number of auroræ noticed by him will be an important minor result of his persistent labors. The telescope employed by Dr. Schultz was of thirteen feet focal length, whence we may gather that similar desirable work is fully within reach of a number of telescopes in the United States.

PUBLICATIONS OF THE OBSERVATORY OF BOTHKAMP.

The private observatory of the Councilor von Bülow, at Bothkamp, has just published its third volume of "Observations," under the editorship of Dr. O. Löhse, astronomer of the observatory, and announces the speedy issue of a fourth volume. The present volume is devoted to physical investigations on the nature of the sun's surface, to the registration of solar spots, and to the study of solar spots, faculæ, etc. It is illustrated with plates of solar spots, etc., and we note that one of the large spots drawn is the same already studied by M. Trouvelot, a drawing of which was published by Professor Winlock in the astronomical engravings from Harvard College Observatory. The observatory of Herr von Bülow was the first one in Germany to be devoted solely to celestial physics, and its great success may have had much to do with the establishment of the *Astrophysikalischen Institut*, at Potsdam, by the Prussian government.

THE SOLAR PARALLAX.

Professor Galle, who has endeavored to calculate the solar parallax from observations of the asteroid Flora, announced as the final result of his computations 8.879″ as deduced from 36 southern and 37 northern stars, the distribution of the comparison stars being as favorable to an accurate result as is possible. The greatest probable error that we can ascribe to this result is the one twenty-fifth of a second. But it is very remarkable, if we divide his seventy-three equations into three sections of twenty-four or twenty-five observations each, that we deduce the following values, viz.: 8.96″, 8.86″, and 8.78″. The whole computation will at some future time be published in full; but Professor Galle states that he has come to the conclusion that so accurate a result with so small a probable error could only have been accomplished by the kind co-operation of the observatories of the southern hemisphere, and that even a still better approximation can perhaps by this method be attained in the future. To this end the observations should, if ever repeated, be made with the largest telescopes, using the highest magnifying powers. As constant errors can be eliminated by a proper arrangement of the observations of the stars of comparison, it becomes more important to diminish the effect of accidental errors by a large increase in the number of observations. It is interesting to add that the preliminary results of the observations of the recent transit of Venus, as presented to the Paris Academy of Science, agreed completely with the figures deduced by Dr. Galle.—*Astr. Nach.*, LXXXV., 270.

PRIZES PROPOSED FOR ASTRONOMICAL WORKS IN 1876.

The French Academy of Sciences announces that in 1876 it will give, besides the Lalande medal, a prize (the Damoiseau prize) for the best memoir on the following subject: "Revise the theory of the satellites of Jupiter: discuss the observations, and deduce the constants which depend upon them; especially determine the velocity of light; finally, construct special tables for each satellite."—6 *B*, *Dec.* 22, 1875, 1376.

THE LALANDE PRIZE.

The Lalande prize of the French Academy is given yearly to the astronomer who shall publish the most useful memoir or make the most important observation. This has been awarded for 1875 to M. Perrotin, of the Observatory of Toulouse, for his astronomical observations, and particularly for his discovery of asteroids. The brothers Henry, of Paris, and MM. Borelly and Coggia, of Marseilles, have received this medal in previous years for the same kind of labors, as has also Professor Watson, of Michigan University.—6 *B*, *Dec.* 22, 1875, 1311.

THE INNER SATELLITES OF URANUS.

These objects, which were discovered by Lassell with his two-foot reflector, have lately been the subject of some discussion. In *Mon. Not. R. A. S.* (vol. xxxv., p. 16), Professor Holden, of the Naval Observatory, advanced the opinion, after a comparison of William Herschel's observations of small objects near Uranus in 1789–1815 with tables of the motion of these bodies (published by Professor Newcomb of the same observatory, in the "Washington Astronomical Observations for 1873," Appendix I.), that William Herschel had really seen both Ariel and Umbriel, and that he had observed them.

Lassell, in the same number of the *Monthly Notices*, disputed the evidence adduced, and claimed that not only was he the discoverer of the very faint bodies, but that he first saw them. Both Professor Newcomb (op. cit., p. 43) and Professor Holden doubted the reality of some observations of Ariel made by Dr. Vogel at Bothkamp with a telescope of 12 inches aperture, and published in the "Bothkamp Observations," vol. i., on account of the extreme faintness of these bodies even in the much larger telescope of the Naval Observatory (26 inches). Dr. Vogel has published in the *Astronomische Nachrichten* (bd. 87, col. 52) other observations of objects near Uranus, made in 1871, some of which agree well with the ephemeris by Mr. Marth. From this he concludes, with strong probability, that under some circumstances Ariel and Umbriel (the inner satellites) can be seen with a telescope of no more than 12 inches aperture. Since the publication of this paper Professor Holden has been able to see the inner satellites with an aperture of 15 inches on the Washington equatorial.

FUNDAMENTAL STARS OBSERVED AT HARVARD COLLEGE OBSERVATORY.

To meet the demand for a greater number of polar and clock stars, Professor Winlock, Director of the Harvard College Observatory, began in 1872 a series of observations with the new meridian circle upon a list of 373 polar and clock stars (148 of less than 30° of N. P. D.). These observations were made in 1872–3 by Mr. William A. Rogers, assistant, and the right ascensions are published in *Astronomische Nachrichten*, bd. 87, col. 67. The new Oxford Observatory has also undertaken, under the direction of Professor Pritchard, a work of this kind.

SOLAR SPOTS.

Gauthier states that as the results of three and a half years of observations on the solar phenomena, by means of the equatorial of the observatory at Geneva, kindly put at his disposition by Professor Plantamour, he finds himself entirely justified in coinciding perfectly with the theory of Zöllner as to solar spots being scoriæ floating upon the liquid, and possibly even within the denser gaseous portion of the solar surface. They are apparently the result of cooling, depending on the radiation from the surface of the sun; and this explanation by Zöllner is the only one that seems to him not to contradict both ordinary laws of physics and well-known facts.

VARIABLE STARS U, W, AND X SAGITTARII.

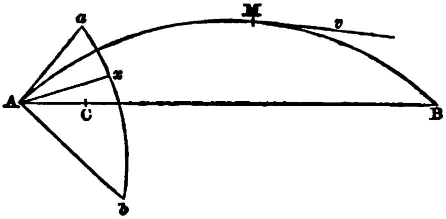
Dr. Julius Schmidt, Director of the Athens Observatory, has lately published the results of his investigations on the variable stars U, W, and X *Sagittarii*. The variations observed in their brightness are of a similar character, as they all have periods in the neighborhood of seven days. These periods, however, are complicated by longer subsidiary cycles of three and a half, eight, and two years respectively. In each case the *increase* in light is more rapid than the *decrease*, the progress from a minimum to the next maximum requiring about three days, and from this maximum to the next minimum about four days. In W *Sagittarii* there is a well-marked secondary maximum and minimum.

No adequate physical causes for these changes have yet been assigned. A still more remarkable and inexplicable case of variation has been investigated by Dr. Schmidt in U *Herculis*. The period of this star is between thirty-eight and forty days, but secondary changes having a period of about twelve hours occur throughout a large portion of the main cycle certainly, and possibly throughout the whole duration. These secondary changes are large in amount for the eight or ten days near each minimum, but quite small near the maxima.—38 *C*, Nos. 2071 and 2075.

SOMOFF'S BARYCENTRIC THEOREM.

Somoff has presented a note to the Academy of Sciences at St. Petersburg on a barycentric theorem discovered by him, and which offers an elegant method of expressing the duration of any movement whatever of a point with reference to two right lines. The theorem may be ennunciated as follows:

Let T be the duration of any movement whatever of a point, M; and let the curved line AMB be that described during the time T; AB will be the chord that limits the space AMB. Put v for the velocity acquired by the body, M, at any moment, t. Let Ax be a variable line that, starting always from A, remains during the whole time, T, equal and parallel to the velocity, v, and pointing in the same direction. Finally, let ab be the arc described by x during the interval T; that is to say, ab will be the hodograph of the velocity, v.



Conceive now any mass so distributed along ab that the density at the point x shall be in the inverse ratio of the force which solicits the point M, or of the acceleration of the first order.

It can now be shown that the centre of gravity, C, of this mass lies on the chord AB, and that the ratio $\frac{AB}{AC}$ is equal to the duration T. We may, therefore, consider the line AC in length and direction as the mean of the velocities which the projection of M upon the chord AB acquires during the time T.—*Bull. Acad. Sci. of St. Petersburg*, 1874, 258.

THE SOLAR SPOTS AND PROTUBERANCES OF THE SUN FROM 1871 TO 1875.

Father Secchi, in giving a review of his observations on the solar spots and protuberances for the past four years, states that they extend over about fifty-two rotations of the sun upon its own axis (or solar days). The average number of protuberances observed each day, which was about fifteen in 1871, was reduced to from four to ten in 1870, the average of the whole period being about ten, and the progressive diminution being very regular. The area covered by the protuberances was reduced in a similar proportion, viz., from fifteen to five. In 1871 the average number of groups of spots was about twenty-five, which number was reduced to six or seven in 1875. The surface covered by the spots has diminished to ten in 1875, being ninety in 1871. It is evident that the solar activity, as far as manifested by the quantity of spots, corresponds to the activity presented by the protuberances. The parallelism is not absolute, however, nor could this be expected, since certain protuberances, being purely hydrogen, have nothing to do with these solar spots. In consequence of this being a year of minimum of solar spots and protuberances, Father Secchi thinks he finds therein the explanation of Professor Langley's result, since the latter gentleman has observed that at present there is no difference of temperature between the sun's equator and its poles.—6 *B*, LXXX., 1273.

THE SOLAR OBSERVATORY AT POTSDAM.

Some account of the new German solar observatory established at Potsdam, near Berlin, is given in Klein's *Wochenschrift*, from which we gather that this institution is situated upon a considerable elevation, and will consist of a group of several isolated observing domes, each to contain its own telescope. Of these domes, the southern one, having a telescope of eleven inches aperture, will be devoted to spectrum analysis, which observations will be applied also to the stars as well as the sun. In another dome the heliograph will be established, which will be devoted also to the photography of the sun, and possibly of the moon and stars. The western dome will contain a telescope of eight inches aperture for special investigations of sun spots and protuberances. The eastern dome will contain the telescope of seventeen feet focal length now employed by Professor Sporer for the study of the protuberances. North of these domes will be the principal building, devoted to optical, physical, and chemical researches, and north of it will be rooms for the assistants, micrometric apparatus, etc. Still north of this building will be one containing a large tank of water, in whose cellar magnetic apparatus will be established.

At the depth of one hundred feet under the ground a space will be provided for erecting a Zöllner's horizontal pendulum. Finally, the dwelling-houses are to be mentioned, which will accommodate quite a number of observers and officials. In connection with the prosecution of Professor Sporer's observations of sun spots and protuberances, it is stated that one of the most brilliant protuberances recently appeared in the polar region of the sun, where they are generally wanting. It shot forth in nineteen minutes, and indicated with certainty the presence of a violent storm at that point.—*Klein's Wochenschrift*, 1875, 249.

SPECTROSCOPIC DIAMETER OF THE SUN.

At the recent meeting of Italian astronomers, experiments were made by Secchi, Tacchini, Rayet, and Dorna to determine the difference between the diameter of the sun as determined by the spectroscope and by the method of meridian transits. From the observations of ten days the spectroscopic semi-diameter was *less* than the transit semi-diameter by 0.124″, and *less* than the Nautical Almanac semi-diameter by 0.104″. Atmospheric conditions were found to be influential in these determinations.—2 *G*, *November*, 1875, 118.

IDENTITY OF COMET VII., 1873 (COGGIA), WITH COMET I., 1818 (PONS).

Dr. Weiss, of the Vienna Observatory, has investigated the orbit of the comet discovered by Coggia the 10th of November, 1873. As he has previously shown, there is scarcely a doubt that this comet is identical with the comet discovered by Pons in 1818, and in this case the determination of the period of revolution is quite important. Dr. Weiss finds that there are three possible periods, viz., 55.82 years, 18.61 years, and 6.20 years. Of these three, the second is the least probable; and of the first and third, Dr. Weiss considers the period of 6.20 years the most probable for the present, although his computations are to be carried farther as soon as he shall have received further observations of this body during its last appearance.—38 *C*, No. 2072.

A NEW MERIDIAN INSTRUMENT AT THE OBSERVATORY AT RIO.

M. Liais, Director of the Observatory of Rio, describes a new arrangement of his mural circle (made by Dollond), which is intended to convert it into an instrument suitable for determining right ascensions. Within the tube of the mural-circle telescope, M, is fixed a plane mirror, which is perpendicular to the axis of rotation of the mural circle. At ten feet from the circle, and looking toward it, is a telescope with high magnifying power, A. Close to A is a mark (*mire*) which can be moved either vertically or horizontally by means of two micrometer screws of known value. If M is in any given position, the mark can be placed, by means of its micrometer screws, so as to be seen on the cross-threads in the focus of A. If the mirror is truly perpendicular to the axis of the mural circle, and that axis is perfectly regular, the telescope, M, might be turned in any position, and the mark would still be on the cross-threads of A. If, however, in a given position of M the mark is *not* on these threads, the micrometer screws of the mark will serve to bring it back to these threads, and in this way it may be determined how far the normal to the surface of the mirror is displaced horizontally and vertically for each position of M. In this way the position of M may be referred to a vertical plane passing through the north and south collimators of the mural circle. The ordinary formulæ for the transit instrument will serve for this purpose if, first, the angle formed by the optical axis of M with the fixed vertical plane (if the mirror is put into that plane) be substituted for the error of collimation; second, if for the error of azimuth be substituted the angle between the vertical plane through the normal to the mirror and the vertical plane perpendicular to the plane of reference; third, if for the error of inclination be substituted the angle between the normal to the mirror and the horizon.

These quantities can be determined from the micrometers of the mark, first, when the telescope, M, is directed on the two collimators, and, second, when directed to the star observed. In this way the observations are reduced to the plane of reference, and this can be referred in the ordinary way to the meridian.

The south collimator at Rio is a mark in the focus of a long-focused objective. The north collimator is the axis of the prime vertical transit instrument, which is itself provided with collimators. Thus the meridian instruments of this observatory form one connected system. The device of Liais serves also to investigate the flexure of the telescope M.—6 *B*, LXXXII., *February* 28, 1876, 495.

THE SOLAR ECLIPSE OF APRIL 16, 1874.

Mr. E. J. Stone, Astronomer Royal at the Cape of Good Hope, observed the total solar eclipse of April 16, 1874, at Klipfontain, Africa, fifty-five miles from the coast. Mr. Stone's plan of campaign was necessarily simple, as the difficulties of travel in South Africa prevented the transportation of delicate appliances, but the points to which he directed his attention were, although few, perfectly definite. By circulars distributed throughout the colony, instructions were communicated as to the proper methods of making drawings of the corona, and several important drawings were received, which are carefully studied by Mr. Stone. They exhibit the usual marked discrepancies in most cases, notably in two made by two expert draughtsmen seated side by side at the same table; but Mr. Stone gives a satisfactory explanation of the differences here, which may serve to account for similar discrepancies in former drawings. Mr. Stone summarizes the results of his expedition as follows:

"1. A confirmation of Young's observation of the general, or nearly general, reversion of the Fraunhofer lines in the spectrum of the corona near the photosphere.

"2. A spectroscopic examination of the outer corona, in contradistinction to the inner corona, carried to the extent of rather more than a degree from the sun's centre, which has proved that the spectrum of the outer corona consists of a linear spectrum of one bright line, either exclusively or sensibly, whose wave length is 5.312, with a unit of one tenth of a meter, and of an ordinary sunlight spectrum with absorption lines. The spectrum of the outer corona has been shown to fade gradually away, as the extreme visible limit of the corona is approached, and not to disappear sharply, as if the extreme limit of the corona had been reached.

"3. The spectroscopic examination of the outer corona, combined with the unchanged character of its principal features, as seen at [three different observing stations] at intervals of absolute time extending to ten minutes, and at distances of more than 500 miles, proves, I venture to think, the solar origin and cosmical character of the outer corona. . . .

"4. A comparison of the drawing of Mr. Henry Hall . . . and the photographs obtained in 1869 and 1871, shows the permanent character of the contraction of the inner corona in a direction parallel or nearly parallel to the sun's axis of rotation. The strongly marked character of the general contraction of the outer corona in the same direction may not improbably ultimately lead to a similar inference in the case of the outer corona also."—*Memoirs Royal Astronomical Society*, XL., 11.

PHOTOGRAPHS OF THE SOLAR CORONA.

Professor Zenger, of Prague, announces a success which, if confirmed, will be of high importance. By using a new form of "achromatic lens in combination with mirrors of large aperture and very short focal length, so as to reduce the focal length to four times the aperture," Professor Zenger claims to have photographed the solar corona with the protuberances on it, and also to have examined the corona through the telescope. He describes its appearance to the eye as "a bright circular ring . . . on an average one minute in height, and only in exceptional cases of nearly two minutes, and an eccentricity amounting to only two or three seconds of arc."

DISTRIBUTION OF PUBLIC TIME.

The importance of this subject, which is now attracting general attention, will render the subjoined list of the various time-balls, time-guns, etc., of the world, valuable. It has been compiled from the best sources available, but corrections and additions will no doubt be necessary in many cases, as the materials for the compilation are somewhat limited.

List of Time-balls, Time-signals, etc.

EUROPE.

Helsingfors.—There is a time-ball dropped at noon at the observatory, and a gun fired either on the guard-ship or ashore.

Bergen.—A time-ball is dropped daily at noon.

St. Petersburg.—Several public clocks in the city are controlled from the Pulkova Observatory, and a time-ball (*or* time-gun) makes a signal at noon daily.

Kiel.—Time-ball (*or* time-gun) for shipping.

Dantzig.—Time-ball at local noon and at Greenwich 1^h.

Hamburg.—Time-ball (*or* time-gun) for shipping.

Paris.—The public clocks are controlled from the Paris Observatory.

Lisbon.—A time-ball is dropped from the observatory at 1^h Lisbon mean time, and one is dropped simultaneously on the south side of the river from Prayal flag-staff.

Cadiz.—A time-ball is established at Cadiz, but we have no information of the time at which it is dropped.

Neuchâtel.—An extensive system of electrically controlled clocks and of time-signals radiates from this observatory, for the purpose of giving the true time to the chronometer and watch makers, and for the public convenience. Several towns participate in this.

AFRICA.

Cape of Good Hope.—Time-ball at 1^h.

ASIA, ETC.

Madras.—A time-ball is dropped daily from the Custom-house at 8^h 20^m 57.3^s Madras mean [civil] time=15^h Greenwich mean time. The time of the flash of the evening gun is noted at the observatory, and published at the Master-Intendant's office the next morning.

Batavia (*Java*).—There is a time-ball dropped at Batavia mean noon, and also one at 1^h 7^m 12.5^s Batavia mean time= 18^h Greenwich mean time. *Calcutta.*—Daily time-gun.

Vladivostok.—There is a branch of the Russian Hydrographic Office established at Vladivostok, and a naval officer obtains the time daily with a transit instrument, and keeps his clock regulated for the benefit of navigators.

AUSTRALIA.

Melbourne.—A time-ball is dropped daily (Sundays excepted) at 1^h m. s. t. The time is also given from the same place at 8^h (P.M.) by the obscuration of a powerful light at two minutes before 8^h: the instant of reappearance of the light is the true time. The errors of these two signals on any day are published on the next day in the newspapers.

Sydney.—A time-ball is dropped daily.

Newcastle.—A time-ball is dropped daily by signals from Sydney.

SOUTH AMERICA.

Rio de Janeiro.—We have no entirely satisfactory account of the details, but we are informed that a time-ball is dropped daily at noon.

Buenos Ayres.—The Observatory of Cordoba sends electric signals to Buenos Ayres for the regulation of clocks accessible to ship-masters.

NORTH AMERICA.

St. John's (*New Brunswick*).—Time-ball daily (except Sunday) at one o'clock, by a chronometer which is compared with a clock rated by a transit instrument.

Quebec.—A time-ball is dropped for the shipping at 1^h, and a time-gun fired in the city for public convenience at noon.

Kingston (*Canada*).—Time is given to the city and to the shipping daily from the observatory.

Ontario.—For the past four years the observatory has struck its time-signals on the fire-alarm bells.

Pittsburgh.—The City-hall clock is controlled from the Alleghany Observatory, and the fire-alarm bells are struck at noon and at every third hour. Time is furnished to the Pennsylvania Railway.

Cincinnati.—The clock on the City-hall is controlled by electric signals every two seconds, and the fire-alarm bells are struck at noon.

Cambridge and Boston.—For some years the Harvard College Observatory has controlled clocks in Boston, and furnished standard time to some of the railways.

Albany.—It is understood that the Dudley Observatory furnishes time to the city of Albany and to the Hudson River Railway.

Chicago.—Time is given to the city from the Dearborn Observatory.

Washington.—A time-ball is dropped daily (Sundays excepted) at noon. Clocks in the city are controlled (on Jones's system) at the Navy Department, State Department, Treasury Department, Signal-office, and one is proposed for erection at the Western Union Telegraph Office. Daily (except Sundays) at noon a signal is sent from the observatory to the Washington office of the Western Union Telegraph Company, and by them distributed over such of their wires as may be unemployed. Practically this signal *always* reaches Philadelphia and New York, and Chicago, Cincinnati, and St. Louis very often. The fire-alarm bells are struck at 7 A.M., 12 M., and 6 P.M.

GREAT BRITAIN.

Glasgow.—The wire formerly owned by the observatory has been transferred to the government telegraphs, which distributes the time-signals to the public at very low rates: for example, £1 yearly is charged for a clock controlled within one third of a mile of the office, etc.

Liverpool.—A time-ball is dropped daily at 1^h visible to the shipping, a time-gun is fired at the same hour at the Morpeth Dock pier-head; the clock in the Victoria Tower (six dials) is controlled, as well as several clocks in the city.

Edinburgh.—A time-ball, visible to the shipping in the Firth, is dropped daily from Nelson's Monument on the Calton Hill, a gun is fired from the Castle, and numerous clocks are electrically controlled, some of them being exposed for the convenience of the public. Time is sent daily to Dundee.

Dun Echt.—At Lord Lindsay's private observatory at Dun Echt, near Aberdeen, a time-gun is fired daily for the public convenience.

Dundee.—Signals are received daily from Edinburgh at an expense of £100 per year, and a time-gun is fired automatically.

Deal.—A time-ball is dropped at 1^h from Greenwich.

Portsmouth and Start-Point.—Time-balls (at 1^h) are proposed.

Dublin.—Greenwich time-signal is received daily at 10^h A.M., and distributed. We are not informed as to details.

Belfast.—Greenwich time-signal at 10 A.M.

Guernsey.— " " " "

Newcastle.—Time-gun automatically fired at 1^h Greenwich time.

Sunderland.— " " " " "

Middlesboro'.— " " " " "

Kendal.— " " " " "

Norwich.—Greenwich time is distributed.

Stockton.— " " " "

Worcester.— " " " "

Nottingham.— " " " "

Devonport.—Time-balls are dropped on Mount Wise at 1^h and at $1^h\ 5^m$ Greenwich mean time.

Greenwich.—A time-ball is dropped daily at 1 P.M.; a ball is automatically dropped at Deal. Time-balls are proposed for Portsmouth and Start-Point. Hourly currents are sent from the observatory to the Post-office, from which they are distributed to subscribers. Currents are sent automatically at 10 A.M. and 1 P.M., and widely distributed; and almost daily signals are sent directly to about 600 places, including railway termini, and from these places they are repeated to the lines radiating therefrom. The system is practically complete.

VISIBILITY OF STARS IN THE DAY-TIME.

Dr. Rudolf Wolf communicates to the Philosophical Society of Zurich (20th year, page 179) a note on the visibility of stars in the day-time from the bottom of deep wells. It appears that Mr. F. Carpentier, of Zurich, tried the experiment of looking for stars in the day-time from the bottom of a deep well (ninety feet), and that he was successful. It was done when the experimenter was but a lad, and although there is no doubt as to the fact, the names of the stars seen and the particulars of the observation can not be recovered.

MEASURE OF TIME BY HOUR-GLASSES.

Dr. Wolf, of Zurich, having occasion to use an hour-glass which was intended to mark half-hours, endeavored to determine the probable error of a measure made by means of this instrument. The ending of the flow of sand could be observed quite exactly, *i. e.*, to within one second of time; the mean of sixty trials gave him for the time of flow $28^m\ 29.95^s \pm 5.7^s$. The probable error of a single observation was no less than 43.9 seconds. It thus appears that this instrument, which was extensively used by the ancients, is not a trustworthy one for exact determinations.

B. TERRESTRIAL PHYSICS AND METEOROLOGY.

MECHANICAL THEORY OF OCEAN CURRENTS.

The application of mathematics and the laws of mechanics to the theoretical investigations of the currents of the atmosphere and the ocean, with which subject American students have become so familiar through the labors of Professor Ferrel, has of late years been taken up quite energetically in Europe; and to the labors of Colding, Peslin, Everett, Thomson, Hann, and others, we now have to add the somewhat elementary memoir of Professor Blazek on the elements of a mechanical theory of the ocean currents, which communication is, he implies, introductory to a more extended memoir that may be expected from him. He considers that every particle of water is actuated by two forces—that of gravity toward the centre of the earth, and the centrifugal force due to the daily rotation of the earth. The centrifugal force in and of itself can produce no constant current, since it is in obedience to it that the earth owes its permanent ellipsoidal shape; but if on such an ellipsoid the temperature in general diminishes toward the equator and toward the two poles, there results a tendency toward a new distribution of the mass of the water, which therefore demands a new figure of equilibrium. The dense, cold waters of the two polar seas, therefore, flow toward the equator, while the lighter warm waters flow from the equator toward either pole. Less water flows from regions of low temperature toward the regions of high temperature, and the northern hemisphere sends to the equator less cold water than the southern hemisphere. Consequently, as he demonstrates, the centres of all the closed portions of the equatorial currents in all oceans are found between the 35th and 30th parallel of latitude. The centrifugal force drives the cold water toward the equator and the warm water toward the polar regions, and in consequence of the earth's rotation these latitudinal currents are turned aside—those from the poles to the west, and those from the equator to the east.—*Sitzb. K. Böhm. Gesell.*, 1874, 195.

THE TEMPERATURE OF THE SEA.

Observations on the temperature of the sea have been made at Falmouth, England, continually since the autumn of 1871. It was at first proposed to make the observations about the time of high water in Falmouth harbor, it being thought that, owing to the great extent and depth of the harbor, the influence of the shore would not be felt when the water had freshly come in from the open sea. But it soon became apparent that results obtained in the harbor and near the shore were worthless. Experiments proved that differences of several degrees of temperature existed within very small limits of space; and Mr. Dymond, by whom the observations had been made, states that he has reason to think that observations on the temperature of the sea are, in general, of little or no value unless they are made from a vessel considerably outside of low-water mark. It was therefore determined, within a few months after the observations were begun, to make them in the open sea, at distances varying from half a mile to three or more miles from the nearest land. During the three years—1872, 3, and 4—observations were made on 747 days; and the mean of all these readings is 53.23°, while the mean of the 36 highest and 36 lowest monthly readings is 53.25°. The monthly range of the sea temperatures varied from 2° in March to 6.5° in July. The importance of making similar investigations at other stations where sea temperatures are systematically observed is forcibly suggested by this result of Mr. Dymond's studies, and it is evidently highly desirable that the light-ships stationed along our coasts should be utilized, whenever possible, for the purpose of observing sea temperatures.—*Forty-second Annual Rep. Royal Cornwall Pol. Society*, p. 105.

ORIGIN OF VOLCANIC ASHES.

Professor Von Roth communicates to the Berlin Academy of Sciences an investigation into the origin of the volcanic ashes that fell in Scandinavia on the 29th and 30th of March. He shows that these were the product of the great volcanic outbreak in the eastern half of Iceland at Vatna, as well as in the Dynqu Mountains.—*Monatsber. Berlin Acad. der Wiss.*, 1875, 256.

ABNORMAL DEFLECTIONS OF THE PLUMB-LINE.

Lieutenant F. V. Greene, Engineer Corps, U. S. A., has recently discussed the station-errors of the 41 astronomical stations established on the 49th parallel of latitude by the joint commission of English and American engineer officers, for the purpose of marking the boundary-line between the United States and the British possessions. The 41 stations were all observed with the zenith telescope, and of them 19 were observed by the English alone, and the average probable error of the final latitude of a station was ±0.088″; 17 were observed by the Americans alone, and the probable error of a station established by them was ±0.059″ (76 observations); and 5 were jointly observed by the two parties, their independent results differing by 0.28″, 0.27″, 0.07″, 0.29″, and 0.31″ respectively. The various stations were connected geodetically by the method of tangents and offsets; and the difference between the astronomical and geodetic determinations was assumed to be due to abnormal variations in the local directions of gravity, and was called "station-error."

Sufficiently accurate topographical work was done to enable 200-feet contours to be laid down on the maps. From these contours Lieutenant Greene has calculated A (see table), which is the deflection of the plumb-line produced by all masses above the ground within a radius of ten miles, and B, which is the deflection which would be produced by masses between ten and sixty miles distant. This has been done with reference to each of the 41 stations—a work of no little difficulty—and the results are given in the accompanying table. D is the observed deflection, and $D-(A+B)$ is the outstanding residual and unexplained deflection. These quantities for 37 stations in the Ordnance Survey of Great Britain were $D=2.05''$, and $D-(A+B)=1.35''$. From this it appears that for 29 stations the abnormal phenomena are partially accounted for and in the right direction; for 12 stations the computed deflection is in the wrong direction. The quantity $D=2.15''$ which is to be accounted for is about the same in magnitude as the mean error in latitude (2.64″) found by Bessel from a discussion of all the great arcs previously measured, and goes to show that the mean heterogeneity of large tracts of the earth's surface is about the same in every part of the earth itself:

Stations.	D.		A.*	B.		D—(A+B).	
	Station Errors. Mean Parallel=0.		Computed Deflections. 1 to 10 miles.	Computed Deflections. 10 to 60 miles.		Unexplained Deflections.	
	″	″	″	″	″	″	″
1.....		−2.31			− .007		−2.30
2.....	+1.52				0	+1.52	
3.....	+2.33				0	+2.33	
4.....	+3.18				− .15	+3.43	
5.....	+3.50				− .23	+3.73	
6.....	+2.95		− .42		− .27	+3.64	
7.....	+2.22		− .09		− .46	+2.77	
8.....	+1.40				− .36	+1.76	
9.....		− .21			− .54	+ .33	
10.....		−1.78	− .09		−1.16		− .53
11.....		− .78	− .15		− .74	+ .11	
12.....	+ .06				− .65	+ .71	
13.....		− .30			− .46	+ .16	
14.....		−1.91			− .68		−1.23
15.....		−2.23			− .83		−1.40
16.....		− .50			− .92	+ .42	
17.....		− .31			−1.07	+ .76	
18.....		− .94			− .99	+ .05	
19.....	+1.77				− .38	+2.15	
20.....		−1.91		+ .10			−2.01
21.....		− .81		+ .80			−1.60
22.....	+ .98			+1.50			− .52
23.....		− .76		+1.90			−2.66
24.....	+1.54			+3.29			−1.75
25.....	+2.00			+2.16			− .16
26.....	+3.55			+2.85†		+ .70	
27.....	+3.03			+2.80†		+ .23	
28.....	+1.61			+2.03			− .42
29.....	+5.94			+1.38		+4.56	
30.....	+4.30			+ .99		+3.31	
31.....	+2.09			+ .95		+1.14	
32.....		− .67			−1.43	+ .76	
33.....		−5.32	−2.31		−1.77		−1.24
34.....		−7.95	−7.25		−1.37	+ .62	
35.....		− .67			−1.04	+ .37	
36.....		− .52			−1.00	+ .48	
37.....		−1.17	?	?			
38.....		−3.42	?	?			
39.....		−6.09	?	?			
40.....		−2.42	?	?			
41.....		−1.00	?	?			
Σ......	43.97″	43.98″				36.08″	15.82″
Means..	2.146″					1.442″	

* The stations at which deflections, A, are not computed were situated in the midst of plains, where the deflection, A, would not amount to 0.4″, the uncertainty of the determination of D.

† Carried to 80 miles.

ON THE TEMPERATURE OF THE MEDITERRANEAN SEA NEAR THE COAST OF ALGERIA.

Messrs. Grad and Hagenmüller, in 1872, made a series of observations on the temperature of the water, on the occasion of a voyage along the shores of Algeria, and have continued them at three fixed stations since that year. The mean temperature of the surface through the year is found to vary from 18.3° Centigrade at Algiers, up to 19.5° at Oran; the extremes between winter and summer being 11° and 18° respectively. Observations were made at different depths, down to four meters, at the fixed stations; and by comparison of the Algerine with the Adriatic measurements, it would seem that the isothermal lines on the surface of the Mediterranean bend toward the mouth of the Adriatic Sea, where the temperature is higher during the winter and spring time. —6 *B*, LXXXI, 292.

UNDERGROUND TEMPERATURES.

In some notes on the general facts relating to underground temperature, Mr. Schott states that the earth's solid crust being hotter than the mean temperature of the lower stratum of the atmosphere resting on its surface, heat is constantly and very slowly passing outward, and strata of equal depth would have very nearly uniform temperatures but for the influence of the irregular daily and annual variations of the atmospheric temperature received by conduction. The depth of the stratum of the so-called invariable temperature (viz., where the changes escape ordinary observation, or are less than 0.01° Centigrade) is found about six meters below the surface of the ground in the tropics, and about thirty meters below the surface in the middle latitudes. The depths at which the daily variations become imperceptible are, for these two regions of the globe, respectively 0.3 and 1.3 meters. These numbers, however, depend greatly upon the kind of soil or rock forming the surface, and differ considerably according to the porosity of the loose soil. The mean temperature of the earth's crust increases with increasing depth, and for moderate depths the increase is nearly uniform at the rate of 1° Centigrade for 28 meters. For greater depths, the descent necessary to produce an increase of 1° of temperature is greater than this figure. The depths at which the daily and annual variations respectively disappear are in the proportion of 1 to 19; or as the square roots of the lengths of the periods. The amplitudes of the daily, annual, or other periodical changes diminish in a geometrical ratio as the depths increase arithmetically. The time required for the heat wave to reach a depth of 7.3 meters at Edinburgh is nearly six months. Therefore the maximum temperature at this depth is synchronous with the minimum temperature at the surface. Mr. Schott computes, from the best data available, what should be the average invariable temperature at the depth of 229 meters underneath Chicago, corresponding to the depth from which water flows in a certain artesian well. The actual temperature observed is only 12.8°. The computed temperature is 16.2°. The explanation of the discrepancy can not be satisfactorily given, unless observations are made upon the influence of the lake water, and the actual rate of increase of temperature at that spot.—*Report Sec. Smithsonian Institution*, 1874, 249.

FORMATION OF BASALT COLUMNS.

Mr. Robert Mallet republishes in full his views on the origin and mechanism of the production of the prismatic or columnar structure of basalt. He states that our knowledge of the mechanism of the jointing of masses of rock is still very far from being complete, but less complete is our knowledge of that which constitutes the complicated systems of joints shown in columnar basalt. The best-known writers are generally at variance on this subject, although the most philosophical views are those that have been defended by Professor James Thomson, now of the University of Glasgow. According to Mr. Mallet's investigations, the primary conditions for the production of straight prismatic structure in basalt are, first, general homogeneity of the material; second, a tolerable regularity in the general form of the mass; third, inequality in the rate of cooling in one or more directions. The more or less horizontal and tabular masses of basalt as they occur in nature are usually cooled most rapidly from their upper or lower faces; or, if the basalt be found filling a dike, then the rapid cooling has taken place on the two opposite surfaces of the dike. When, in consequence of this cooling, the surface of the volume of plastic rock has arrived at that temperature at which its rigidity becomes sufficient to prevent its yielding to the contractile strains in any way except by its splitting up into much smaller surfaces which can draw off from contact with each other, then the principle of least action, or that principle which as a universal law governs every operation of nature by which a given effect is produced with a minimum expenditure of work, comes into play; and in consequence thereof the mass of rock is split up, not into triangular nor into square columns, which might otherwise be possible, but into horizontal prisms. The temperature at which various metallurgic slags and the temperature at which actual lavas lose their plastic or viscous condition and assume sufficient rigidity to break, varies between 900° and 600° Fahr. The prisms thus formed, being cooler at their extremities and warmer in the middle of the mass, are thus subject to strains as the cooling process proceeds which break them up into shorter lengths. These lengths slightly exceed the diameter of the prism and the fracture separating two adjacent lengths must be of a cup-shaped form, as being also the result of the unequal temperature of the mass. In general, the convexity of the cross-joints will point in the reverse direction to that in which the wave of heat has been transmitted from any cooling surface of the mass. The regularity of the shape of the prisms and their joints will be sensibly affected if there be foreign material or empty cavities existing in the mass of the basalt, since these circumstances affect the rate of cooling. Thus in walking over the tops of large pavements of basaltic columns, such as those exposed at the Giant's Causeway and elsewhere, one sees places in which the hexagonal form becomes irregular, and gives place—though for a very small extent of surface—to quadrangular and other irregular forms, sometimes even triangular or wedge-shaped; but passing on a short distance we find these rapidly return to the normal hexagonal type. Curved or bent prisms must also be produced in consequence of those forces that are brought into play when the bounding surfaces supporting the whole mass of cooling basalt are themselves curved. — *Philosophical Magazine, August and September*, 1875.

EARTHQUAKES IN ITALY.

The supplement to the *Meteorologia Italiana* for 1874 contains a memoir by Serpieri on the earthquake of the 12th of March, 1873, concerning which the veteran Alexis Perry says that it has laid the foundation for connecting together in a philosophical manner all the seismic and volcanic phenomena of Italy; and crowning as it does the well-known labors through so many years of Serpieri, it forms a fitting memoir with which to begin the Bulletin of Vulcanology in Italy. In this memoir the author begins by the study of the signification of the records of earthquakes made by self-recording pendulums. Self-registering seismographs have been invented by numerous Italians, to say nothing of those of Hopkins, Forbes, Mallet, and other foreigners. The most successful of the Italian investigators in this respect would seem to have been Bertelli, who, with De Rossi, has paid attention to the study of the minute, almost microscopic movements of the pendulum which precede severe earthquakes, and which have been studied by the help of ninety-four accurate observations at as many different stations as they were reported to Serpieri. These were very equally distributed on all sides of the central disturbance, and show that the original shock was of the nature of a line of fracture extending from near Florence southeastward about fifty miles, within which region it seems possible that several fractures may have followed each other in rapid succession over neighboring portions of territory. A comparison of the observations made on the 12th of March, 1873, with those made on the 6th of December, 1874, and the 24th of February, 1875, as calculated by De Rossi in his analysis of the three great Italian earthquakes, show that in all these cases these transverse fractures in the terrestrial crust are succeeded by transverse vibrations in the same.—*Supplemento alla Meteorologia Italiana*, *Rome*, 1875, 56.

NOCTURNAL RADIATION.

Mr. Barham, in communicating to the Royal Institution of Cornwall some remarks on the surface temperature of the earth, states that the common estimate of the greatest cold during the night is derived from the record of a thermometer hanging up on a stand, or under a shed or other shelter; yet the fact is patent to every one that, when the sky is clear, the temperature to which vegetables and man and animals out of doors are exposed is from 5° to 10° lower than that recorded by a sheltered thermometer; and it is just these additional degrees of cold, when the ordinary sheltered thermometer hardly sinks to the freezing-point, that destroy tender plants, and more or less seriously injure others. The difference between the temperature of a sheltered thermometer and that indicated by one partly exposed to radiation toward the sky depends, as is well known, on the cloudiness of the sky; and, if the sky be clear, on the quantity of invisible moisture in the air. A series of observations made for ten years at Helston, by Mr. Moyle, shows that in each year differences of 6° to 12° have been observed, the exposed thermometer being invariably the lower. At Pengerrick, near Falmouth, the difference between the minimum thermometer lying out on the grass and the minimum sheltered in an ordinary thermometer-screen sometimes amounts to 15° or 17°. The thermometers exposed to radiation, and lying not upon grass, but upon other substances, such as garden-mould, snow, sand, stone, and gravel, generally show slightly higher temperatures than those on grass. Their variations among themselves are, however, due to a somewhat complicated relation between the conduction of heat from the interior strata of the earth and the radiative power of the surface stratum itself. The radiative power of straw, whether flax, wheat, or rye, is one of the largest known. A bedding of straw is used, as is well known, in India in the process of forming ice during clear nights. From a series of observations made for a period of eighteen months on garden-loam, sand, clay, and peat, Mr. Whitley found that garden-loam showed a power of receiving and retaining heat superior to that of any other naked soil. The temperature of the peat was nearly equal to the garden-loam, although naturally wet and cold. Silicious sand did not come up to the expectations formed of it. Clay maintained a bad pre-eminence for coldness, but improved by good drainage in the second year's observations. The effect of a thin screen in preventing the radiation of heat at night was shown by some observations which prove that a screen of muslin does not protect the thermometer placed beneath it so well as straw matting. The matting is surpassed in its turn by a trellis-work, such as is ordinarily employed in summer-houses. A slight covering of straw is even more effective than such trellis-work. In general, in the climate of Cornwall, it may be stated that in sharp, dry, clear weather the soil that is covered with vegetation will be from 8° to 10° warmer if it is secured from the sky by straw matting, or other moderately thick material, spread horizontally at the height of three or four feet from the ground. Another element of greater moment in relation to temperature is the movement of the air. The blight caused by a local draught of icy wind may be frequently traced in well-defined lines in a gap in a northeastern hedge along the rows of early plants. A high wind will rob any horizontal screen of its protecting influence, but the placing of wattled hurdles or other effective vertical screens, about four feet high, on the windward side of a tender crop, in rows twenty or thirty feet apart, must be recommended as a preservative measure, even more important than a provision of horizontal screens. An umbrella carried by a person at night serves at times for protection against some 10° of cold, quite as efficiently as it at other times protects against the snow and the rain.—*Journal Royal Institution of Cornwall*, 1874, 111.

THE INTERNAL HEAT OF THE EARTH.

According to *Nature*, Professor Mohr, of Bonn, has made a very important contribution to our knowledge of the causes of the internal heat of the earth. He starts with the proposition that if the interior is still fused, then, as we approach this furnace, with every increasing depth a less space must be necessary to produce the same increase of heat. In other words, the increase of heat per hundred feet must become greater and greater in proportion as we descend. This, however, is directly opposite to the results of the most careful thermometric measurements, which show that at a depth of five or six thousand feet we come to a region in which the temperature ceases to increase; and even supposing large errors in these measurements, we must conclude that the region of constant temperature will be reached before we descend to a depth of fifteen thousand feet. Professor Mohr finds, from all the facts available to him, evidence that the cause of the increase of heat in the interior of the earth must lie in the upper strata of the earth's crust; and the fluidity of the lava ejected from volcanoes is not a remnant of the ancient incandescence of the earth, but is due to a local evolution of heat caused by those shrinkings which have always been produced by the sea and its action upon solid rocks. The internal nucleus of the earth can lose but little heat outward by reason of the bad conductivity of rock, while, on the other hand, in the lapse of ages it must receive and propagate uniformly all the heat due to the shrinkages; thus a constant elevated temperature must prevail in the interior, and therefore that increase of heat which is met with every where in the earth is the result of all preceding heat actions uniformly distributed by conduction in the internal nucleus of the earth.—12 *A*, XII., 546.

ON THE RELATIONS BETWEEN TERRESTRIAL MAGNETISM AND THE AURORA.

It has been suggested by Lemström that terrestrial magnetism proper, although it may exercise a direct action upon those discharges of atmospheric electricity which constitute the aurora, yet can not contribute to the production of the aurora, since that must depend upon certain conditions of the different strata of air. The apex of the auroral bow is rarely in the direction of the declination of the needle, and the variations are too great to be explained as accidental perturbations in the earth's magnetism. The formation of the auroral corona is generally supposed to be an effect of perspective; but if it were due to this alone, the auroral rays should appear to unite at a very sharp angle, which is by no means the case; and Lemström is inclined to believe that one influence of terrestrial magnetism is to bend the auroral beams. In reference to this point, Professor De la Rive states that although the formation of the auroral corona depends upon the directing influence of the magnet upon the electric currents which form the auroral beams, and is not a simple effect of perspective, it must also depend upon the direction of the passage of the electric discharges through the atmosphere; a direction which itself changes with a conductibility, more or less variable, of the different atmospheric strata. Thus the united effect of perspective and flexure ought to give to the rays a curvature and a position which can not always be the same. In short, the electric discharges which take place in the polar regions between the positive electricity of the atmosphere and the negative electricity of the terrestrial globe are the essential and only causes of the formation of the aurora, whose existence is, indeed, independent of that of terrestrial magnetism, since the latter only imparts to it a certain direction, and in some cases a movement. During auroras the most numerous and the most intense currents of terrestrial magnetism flow from the north to the south; but occasionally they are observed flowing from the south to the north. These latter, according to Lemström, are currents of induction; an opinion in which De la Rive agrees.—*Report of Sec. of Smithsonian Institution for* 1874, 234.

ON THE POWER OF LEAVES TO ABSORB AND RADIATE HEAT.

The power of leaves to radiate heat has been investigated by Maquenne, who has for this purpose employed the Leslie cube, one of whose faces was blackened and the other covered with the leaves to be studied. The temperature of the water in the cube did not exceed 40° Centigrade, so that the mechanical structure of the leaves was unaltered. Of eight plants whose leaves were examined, the radiative powers averaged from ninety-one to ninety-seven, that of the blackened face of the cube being one hundred. And it may be assumed that the radiative power is on the average ninety-five for all of these leaves, and possibly for most others. On the other hand, the absorptive powers of the leaves were observed by covering one of the two faces of a thermopile with lampblack, the other with the leaf in question, and exposing these successively to a warm piece of blackened wood. The absorptive powers of these leaves varied, as before, from ninety-four to ninety-seven, the average being ninety-five; and it was concluded that for obscure heat, (1) the emissive and absorptive powers were sensibly equal; (2) they are nearly equal to that of lampblack; and, finally, the determination of the quantity of dew which is deposited upon plants ought to be made by means of blackened pluviometers, or with gauges covered with some substance having a very considerable radiative power. If this were done, we probably should be able to explain the discrepancy which exists when we compare the quantity of water evaporated by the cultivated soil with that which has been furnished to it by the rain. This excess could, in fact, only be accounted for in great part by the dew which covers the plants every clear night.—6 *B*, LXXX., 1357.

ON THE TEMPERATURE OF THE SOIL.

The Messrs. Becquerel have recently made a report to the Paris Academy of Sciences on the results of observations made in 1874 by means of a thermo-electric apparatus on the temperature of the soil at various depths, from forty meters up to the surface. The observations have been made many times a day, but only those made at six and nine A.M., and three P.M., come now into consideration. From a depth of one hundred and ten feet up to a depth of eighty-five feet the temperature was sensibly constant throughout the year. Even at fifty feet the variations were barely perceptible, although at this depth the effect of the penetration of surface water into the soil is ordinarily quite sensible. The effect of a covering of grass, as compared with that of a barren soil, becomes quite perceptible at the depth of twenty inches, where it is found that the covered soil experiences much less violent changes of temperature than a sandy or barren soil; so that even from six o'clock in the morning to three o'clock in the afternoon the protected soil is warmer than the barren soil.

In thé interest of terrestrial physics, it is to be hoped that we shall be able to establish at still greater depths a similar Becquerel apparatus, in order to discover at what point the temperature of the solid earth experiences, or ceases to experience, any changes in a long interval of time, whether in consequence of slow cooling, of earthquakes, or of internal changes.—6 *B*, LXXX., 773.

INFLUENCE OF FORESTS ON WATER-FLOW AND ATMOSPHERIC MOISTURE.

In order to contribute something to the controversy with regard to the influence of forests upon atmospheric moisture, Fautrat states that he has conducted certain observations in the royal forests of Hallette. He first measured the quantity of rain both above and below the foliage of the trees, and endeavored to take account of the evaporation. He finds that soil covered with forests receives six tenths of the whole quantity of rain that falls, the foliage of the trees having intercepted four tenths. The hygrometric observations show that there is always in the neighborhood of the forests a greater quantity of atmospheric vapor than in the neighborhood of cleared lands; and this envelope of moisture is beneficial to the neighboring cultivated lands, as it flows out upon them during the night-time when such lands are cooled by nocturnal radiation, and the moisture is precipitated upon them as dew.—6 *B*, LXXX., 206.

CHANGES IN THE EARTH'S AXIS OF ROTATION.

The excellent investigation of Dr. Nyrèn upon the latitude of Poulkova and its apparent variability was briefly noticed by us at the time of its appearance; but the essay itself having recently come to hand, we will not forbear to mention that he has therein quoted numerous examples of the results found by many astronomers, all tending to show changes, and, in general, diminutions in the latitudes of the observatories of Europe. The special results for Poulkova, as deduced from the observations of Peters, Gyldèn, Nyrèn, and W. Struve, would lead us to conclude that there is even some probability that the variability of the latitude of this observatory may be an apparent one only, and be due rather to some slight error in the adopted value of the precession and nutation. The definitive determination of this point can probably only be reached by observations conducted uniformly at all seasons of the year through a number of years.—*Nyrèn, Die Polhöhe von Pulkowa.*

METEOROLOGY IN GERMANY.

The German Seewarte, at Hamburg, now under the general direction of the Imperial Hydrographic Office, has in a recent circular announced the further extension of its work. The first article relating to its organization being now in course of execution, in accordance with which it has proceeded to develop the system of observations and reports for ocean vessels, and has also established complete collections of charts and works relating to navigation, whose use is free to all vessels in the various German ports, the office has now proceeded to carry out the third section of its work, viz., the collection of weather reports from stations in the interior of the continent of Europe and the issue of storm warnings. The object of the Seewarte is to study meteorology on a grand scale by means of simultaneous observations, and to thereby investigate the movements of the atmosphere as a whole instead of merely studying climatology. There will therefore be established seven first-class observing stations on the German coasts, with self-recording barometers and anemometers. At these observations are made at 8 A.M., 12 M., 4 and 8 P.M., two of which are telegraphed daily to Hamburg. A large number of minor coast stations are also occupied, and two completely equipped stations are supported by the Navy Department. In the interior of the German kingdom there are to be sixteen stations, which will, it is hoped, be supplied by volunteers from among the numerous amateur and professional meteorologists of Germany. The hours of telegraphic observation will be 7 A.M., local time, from April 1st to September 30th, and 8 A.M. from October 1st to March 31st. It seems that the telegraph offices are generally opened at 8 A.M., and this arrangement of hours has long been used by France, Sweden, and Norway. On the other hand, in England, Holland, and Denmark 8 A.M. is adopted uniformly throughout the year, while 7 A.M. is uniformly adopted by Austria and Russia.—*Circulars of July 5 and September* 20 *of Hamburg Seewarte.*

METEOROLOGY OF THE SIEBEN-GEBIRGE.

The greater part of the little pamphlet of communications published by the Sieben-Gebirge Natural History Society is taken up with an account of the meteorology of that portion of Germany. Seven stations are occupied in the neighborhood of these mountains; their altitudes vary from 200 to 700 meters. It appears from these records that throughout the year 1873 unusual warmth and dryness were experienced. The annual means of temperature at all the stations exceeded the normal means by very considerable quantities, while the annual total rainfall was every where less than the normal fall. Vegetation was remarkably forward in the springtime, and uninjured by unfavorable weather through the summer.—*Verhandl. Sieben-Gebirge Verein*, 1875.

METEOROLOGY OF CANADA.

In a recent volume of "Magnetic and Meteorological Observations from 1841 to 1871," Professor Kingston gives first the magnetic results of observations made at Toronto, which may be divided into three principal groups, viz., embracing the years 1840 to 1848, 1853 to 1862, and 1863 to 1871. For the latter group tables of the daily observations are given, while for the former group only summaries, condensed from the full publication of General Sabine, are given. The second portion of the volume is taken up with meteorological observations, and may be divided into two sections, the second of which contains tables of daily means for the period from 1863 to 1871, and the first section more general tables for the earlier periods, together with general formulæ representing the results of the discussion of the entire thirty years of observations. These discussions have been entered into with somewhat unusual minuteness, giving us the most thorough discussion of the climatology that we possess for any point in America, and more complete than most of the similar discussions to which European observations have been subjected.

THE METEOROLOGY OF MOUNT WASHINGTON.

Dr. Hellman has contributed to our knowledge of the meteorology of the upper regions of the atmosphere by a careful discussion of the observations made by the Army Signal-office on the summit and at the foot of Mount Washington in 1872. He finds that, as in Switzerland, the extreme maximum temperatures are attained later in the day, and the minimum earlier, at the summit than at the foot of the mountain. The mean daily range of temperature at the summit is 2.5° Centigrade, at the lower station 6.5°. The average decrease of temperature for the month of May is 0.07° for every one hundred meters of ascent, a result that agrees closely with that found by Hann to prevail on the average throughout Central Europe. The diminution of temperature with ascent varies, of course, with the direction of the wind. It is most rapid with the northwest, and least rapid with the southeast winds, and is evidently much more truly a local than a general physical law, as has indeed already been shown by Hann, Mohn, and others. In general, the difference of temperature between the upper and lower stations is greater in clear than in cloudy weather.—*Zeitschrift für Meteorologie, Vienna*, X., 296.

METEOROLOGY IN THE 17TH CENTURY.

Caspari gives, in the *Revue Maritime et Coloniale*, an interesting review of a work published at the Hague by Vlacq in 1663. The work in question is by Vossius, "De Motu Marium et Ventorum." In this book the theory of the tides takes an important place, and after it the winds are treated upon in a manner showing the state of physics and chemistry in that century. The fable of the four elements is rejected by Vossius; the air is considered by him as being simply rarefied water, the principal source of which is found in the ocean. In reference to atmospheric theorems, the author indicates that observation has shown to him a remarkable correlation between the movements of the barometer and the gusts of wind. "For," says Vossius, "if the barometer is low and tends to rise, the danger is past. It is when it is very high that we know, on seeing it fall, that the tempest is coming. The amplitude of the movements of the mercury is in proportion to the violence of the wind." Our author, therefore, at so early a date as this, proposed to employ the barometer on board of a vessel for the prediction of the weather. In 1660, Otto von Guericke had remarked that a considerable barometrical depression corresponded generally with an atmospheric disturbance; but the inventor of the air-pump did not thoroughly understand the theory of the movements of this instrument; and we are forced to believe that practically Isaac Vossius should have the credit of first formulating this useful law, viz., that it is the direction of the movements at any instant, and not the simple readings of the height of the barometer, which should guide us in our predictions of the weather.—*Revue Maritime et Coloniale*, 1875, 330.

THE RESISTANCE OF THE AIR TO THE MOVEMENTS OF PROJECTILES.

An important subject in artillery practice is the resistance of the air to the movement of the projectile—a question that is also equally of interest in the study of the movements of aerolites. M. Helie has concluded, from experiments made by him, that this resistance can be explained by the very simple formula, $r = a \times v \div b$; where v is the velocity of the projectile, and a and b are constants that vary with the difference of the projectiles. This formula holds good only between velocities of from 1000 to 1500 feet per second. The values of these constants have been determined by Helie for four different kinds of projectiles; and for great range of velocities the agreement between the measured and the computed velocities is remarkably close.—*Revue Maritime et Coloniale*, 1875, 333.

INDICATIONS OF SPRING.

Mr. Southwell recently read before the Norfolk and Norwich Naturalists' Society of England a review of the circumstances attending the publication of Mr. Marsham's "Indications of Spring." It seems that this work, which was published in the last century, was based upon observations which were begun to be made in 1736 by Robert Marsham at Stratton, Strawliss Hall, near Norwich. These observations were continued by Mr. Marsham throughout his life. The results of the first fifty years of observations were communicated by him in 1789 to the Royal Society. Mr. Marsham died in 1797; but his series of observations were continued by his son Robert down to the year 1815. In 1836 the record was taken up by the third Robert, and has continued without interruption until the present time. This series of observations, extending over nearly one hundred and fifty years, relate principally to the phenomena that would naturally be noticed by an observant naturalist; and the manuscript is replete with the most interesting particulars as to the progress of tree planting and growth, treatment of trees, periodic measurement thereof, etc. The earliest appearances of the birds common to that section of the country are quite regularly mentioned. Each year begins with a review of the order month by month, compiled from notes, and a daily register of the natural-history phenomena, interspersed with many valuable observations, and a table of the prevailing winds. It is often said in England that our old-fashioned winters have departed, and that the springs have become later. The "Indications," as they extend over such a long period, and have been kept so nearly in the same spot, offer a good opportunity of testing if such be the case. To this end Mr. Southwell states that he has taken the average days of the occurrence of twenty-five different phenomena, which were fully observed during the ten years 1764 to 1774. He then did the same with the ten years 1864 to 1874. The result showed that the springs are now nine days earlier than they were a hundred years ago; nor does it seem probable that this difference is due to any fault in observing, though it possibly may be partly due to improved drainage and cultivation.—*Transactions Norfolk and Norwich Naturalists' Society*, II., 31.

ON BAROMETRIC PRESSURE IN EUROPE.

The great work of Buchan on the distribution of barometric pressure throughout the globe, and the recent work of Rikatcheff, which is especially confined to the distribution of atmospheric pressure in Europe and Siberia, are now supplemented by a memoir by Buys Ballot, who publishes, in the second part of his *Jaarboek* for 1870, a second edition of his memoir on the annual variation of pressure in Europe. The first edition of this work, which appeared in 1860, afforded the foundation by means of which meteorologists for many years have been able to ascertain when the pressure existing at a given place on any day was above or below its normal value. His present memoir is of much greater extent, and gives, of course, the results of many additional years of observations. It gives the monthly, annual, and decennial barometric means for one hundred and sixteen stations.—*Zeitschrift für Meteorologie, Vienna*, X., 324.

A REMARKABLE SHOWER OF DUST.

On the 30th of March last Mr. Nordenskjöld telegraphed from Stockholm that a vitreous fibrous gray powder fell with snow there during the night; and again, on the same night, in Norway, Dr. Kars observed the same phenomenon over an extensive region. The powder that fell on this occasion having been submitted to Daubrée for examination, he states that, by means of the microscope, he recognizes it as composed of fragments of pumice-stone; but, on chemical analysis, other substances could be found in sensible amount. He concludes that the powder is undoubtedly of volcanic origin; and its great resemblance to the powdered pumice-stone found in Iceland points to that island as its origin. In the course of his remarks, alluding to other showers of powder, Daubrée quotes as an instance the ashes from the burning of the city of Chicago, which fell on the Azores the fourth day after the commencement of that catastrophe; which we allude to here in order that we may state that for weeks before and after the great fire in Chicago in 1872 great areas of forest and prairie land, both in the United States and in the British possessions, were on fire; the smoke and the ashes from which fires were inextricably commingled in the atmosphere with the smoke of Chicago; and we should deem it in the highest degree improper to say that the ashes of Chicago were landed in the Azores.—6 *B*, LXXX., 994.

FAYE'S THEORY OF STORMS.

The *Annuaire* for 1875, of the Bureau of Longitudes, Paris, contains a memoir by Faye, entitled a defense of the law of storms, in which he seems to advance certain theories of his own in order to defend views long since enunciated by Redfield, Piddington, and Reid. The novel views introduced by Faye, and suggested to him first, as he says, by his studies upon the solar phenomena, have been met by some criticisms of Peslin, who states that "the vorticose movement of the air in severe storms, which is needed in the new theory as well as in others that have been broached at different times, allows of a better representation of the direction of the winds at the surface of the earth than is furnished by the circular theories." The constancy with which all storms upon each hemisphere circulate in the same direction is due to the rotation of the earth, according to all other theories, while Faye advances the remarkable explanation that "it results from this, viz., that in strongly curved currents the velocity steadily diminishes as we pass transversely from the concave to the convex side of the current." In regard to the formation of rain in connection with extensive storms, Faye says that "in the air the temperature diminishes decidedly as we ascend. Now the moisture of the air is susceptible of condensation oftentimes by a very moderate diminution of temperature. When, then, the cold air of the upper regions is carried down little by little in its whirling movement into the lower and moister strata, it causes all about it the formation of slight fog. This latter, like an exterior envelope or veil, renders visible thereby the contour of the mass of cold air. Doubtless the air in its descent, being subjected to compression, is warmed up somewhat, but it must remain always colder than the surrounding air, and the envelope of fog will be produced as long as its temperature remains below the dew-point of the general mass of air." To this view Peslin objects that, "according to the general mechanical theory of heat, the increasing pressure to which the mass of air is subjected as it is brought lower and lower into the atmosphere, ought to cause it to be, at any moment, warmer than the surrounding air, and that it ought, therefore, to be always impossible for such descending cold air to condense the vapor of the atmosphere with which it comes in contact." Faye states that the views of Peslin in this latter regard are not new to him, having been explicitly elaborated by Espy, and by the Commission of the French Academy that in 1841 made a formal report on Espy's theories; and he had fully considered this objection before he wrote his recent memoir, which has attracted so much attention, and that the truth of his own view will appear if, instead of confining ourselves to theory only, we combine therewith the observation of what actually takes place in nature.—6 *B*, LXXX., 658.

ON THE AMMONIA IN THE ATMOSPHERE.

Schlösing, in a memoir on the presence of ammonia in the atmosphere, states that the origin of this substance is to be looked for in the action of atmospheric electricity on the nitrogen and in the emanations from the soil, although it is doubtful whether the latter can be a very efficient cause. The direct assimilation of gaseous nitrogen by plants, and the emission of ammonia, is no longer admissible. The entire process is a sort of circulation. Nitric acid is produced by the electrical reactions in the atmosphere, and arrives sooner or later in the ocean. There, after having passed into combination with sea-water and its salts, it is converted into ammonia, and now the nitrogen compound is in a form fit for diffusion.

It passes into the atmosphere, and, moving with it, comes like carbonic-acid gas into the neighborhood of plants deprived of locomotion, to whose nutrition it contributes. There it is fixed in its travels, falls to the ground in decayed vegetable matters, forms arable land, and renders the soil fertile. The ocean, therefore, is to be considered as the main reservoir of nitrogenous compounds, and is, through the currents of the atmosphere, the regulator of the annual distribution of nitrogen over the continents.—6 *B*, LXXX., 175.

FAYE'S THEORY OF STORMS.

In his debate with M. Peslin, Faye has stated some of the features of his views in regard to atmospheric storms as follows: First, cyclones, hurricanes, typhoons, tornadoes, and waterspouts are phenomena of one and the same mechanical nature, and to all of which the same general explanatory theory will apply. Second, since the eye can embrace the two latter phenomena in their totality, while the other three classes of storms are spread over too vast an extent of territory for any one observer to seize all their features directly, therefore we ought at first to begin our discussion and investigation with the consideration of tornadoes and waterspouts, at least if we desire to base our conclusions upon facts only. Third, the greater part of meteorologists attribute these phenomena to a vertical aspiration, whose existence they gratuitously assume at the commencement of their investigation. Under certain statical conditions of the atmosphere this aspiration can, according to them, develop mechanical effects of astonishing power. According to them the gyration which is so characteristic of these storms is only an incidental matter, resulting simply from the reaction of the ground upon the horizontal currents, that ground being animated by its slow daily rotation. This reaction, which changes by only 40° the direction of the lower trade-winds in their long course, is made to describe many circumferences in the space of a few yards and in the interval of a few seconds, in the course of these pretended horizontal currents, whose existence not a single observer has as yet noticed. According to the theorists, these latter converge violently from all sides toward the lower orifice of the waterspout or the tornado, in order then to spring vertically through this narrow orifice up to the region of the clouds under the form of a column, surrounded by vapors condensed by cooling, and spreading as they ascend. Fourth, on the contrary, I submit that the common origin of all these phenomena is found in the upper currents, whose power and directions are clearly shown to our eyes by the clouds, and not in the lower strata, where an almost perfect calm continually reigns. Not, of course, that a calm reigns at the precise spot where the waterspout exists at any moment, but all about it. Upon this capital point, so easy to demonstrate, so frequently denied by observers, and which lends so much to the solution, all the witnesses are agreed. This does not prevent the aspiration theorists from placing violent currents, like immovable layers, around the heart of this perfect calm, which the waterspout or the tornado does not disturb for an instant in its rapid course. Never have we seen in science a similar disregard of facts; a strange indifference which is explained only by the influence of a very ancient and very extended prejudice, whose history I have traced in the *Annuaire* for 1875, and which has caused meteorologists to replace facts by theories upon the stability or instability of atmospheric equilibrium.—6 *B*, LXXX., 660.

THE EFFECT OF MOVEMENT OF THE AIR ON THE BAROMETER.

M. Faye having stated in his defense of the law of storms that the barometer does not measure the weight of the atmosphere above us, but that its indications are to be interpreted by dynamical and not statical principles, this idea has been made by Montigny the subject of a communication to the Belgian Academy, on the different pressures exerted by the air upon the barometer, according as it is in movement or quiet, and upon the estimation by means of the barometer of altitudes in balloon ascensions. Montigny has communicated some five or six memoirs on the relation between the height of the barometer and the pressure of the wind. Among them is a series of interesting determinations of the height of a point in the cathedral of Anvers, by means of barometric observations taken under very varied influences as regards the direction and velocity of the wind. These observations had especially as their object to show that the law of diminution of pressure is not the same when the air is in movement as when it is at rest. Barometric measures made in the tower of the cathedral at Anvers when the air was calm gave results sensibly accordant with the true height as measured by the level. On the other hand, measurements made when the west wind prevailed gave results too high, and those made when the east wind prevailed gave results too low, the difference being fourteen feet. It does not appear, however, that Montigny has taken account of the relative directions between the wind and the opening of the windows and doors of the room in which he was placed—a point which, as is well known from recent investigations, is of the highest importance if so great accuracy would be attained. —*Bull. Acad. de Belgique, Bruxelles*, 1875, 820.

ON THE ACCURACY OF THE ANEROID BAROMETER.

The increasing accuracy of the aneroid barometers as manufactured by the best makers, and the numerous applications of this instrument to the determination of altitudes, have led to several excellent investigations into the errors and reliability of the instrument, among which one of the best is due to G. Grassi, recently published in the supplement to the *Meteorologia Italiana*. The first instrument examined by him was made by Casella, of London, which was compared with an excellent siphon-barometer. Subsequently a number of others, some of them made by different makers, were obtained, and subjected to the same course of investigation. Grassi summarized his results as follows: First, aneroids that are subject to great variations of pressure need corrections which have a regular progression, and are generally of very similar form. Second, each aneroid must have its own proper corrections. Third, there exist pressures for which the corrections are nearly constant. Fourth, there exist other pressures at which the corrections experience sudden changes, sometimes an increase, sometimes a decrease. Fifth, if the corrections are plotted as curves, the ascending or descending portions of these will be sensibly parallel. Sixth, sudden jumps are in a positive direction if the preceding period is one of increasing correction, and *vice versa;* the jumps are negative if the preceding period is one of diminishing correction. Seventh, the magnitude of a sudden jump is proportional to the extent of the period that precedes it.—*Supplemento alla Meteorologia Italia*, *Rome*, 1875, 28.

THE SIMULTANEOUS EXISTENCE OF DIFFERENT CURRENTS OF AIR.

The exact knowledge of the presence of several currents of air in the atmosphere around us is of so great importance to meteorology that we record here the observations made by Chapelas in France. On the 30th of April, at noon, he observed a clear sky with a feeble northeast wind. At two o'clock P.M. a slight thread of cirrus was seen moving rapidly from the west-southwest or southwest, the surface wind remaining still northeast. On the first of May both wind and clouds moved from the southwest at ten o'clock A.M.; and at one thirty P.M. a strong storm, followed at night by clouds and wind from the northwest. On the second of May at seven P.M. there appeared a balloon driven by a wind from the west-northwest to the northeast, while at the surface of the earth it was quite calm. The balloon descending in the Luxembourg quickly, when it arrived at an altitude of about one hundred and fifty feet met a current diametrically opposed to that which it had experienced above, and was carried by it toward the southeast.—6 *B*, LXXX., 1176.

ON THE LAWS OF CYCLONES.

The distinguished astronomer, Faye, of Paris, having been led from his study of solar spots to investigate the subject of terrestrial storms, has developed numerous novel views, which will be found fully noticed elsewhere, and has lately applied these views to the study of the hurricane of February 25, 1860, in the Indian Ocean. In this hurricane some forty vessels were destroyed, and their loss is attributed by him in great part to implicit confidence of the navigators in the laws for avoiding the centres of hurricanes that have hitherto been promulgated. It is well known that Mr. Meldrum, by studying this same storm, was led to certain modifications of the ordinary hurricane laws, but Faye differs widely from his conclusions. Similarly Captain Ansart proposed to reject the circular theory of cyclones, and to substitute ellipses for the spirals of Mr. Meldrum. By referring to the original observations, so far as they are available for the study of this storm, Faye concludes that it is necessary to take account of the trade-winds in enunciating the laws of those storms which occur in the regions of those winds; and he proposes the following practical conclusions which he would submit to navigators:

"In order to determine the position of the centre of a cyclone in the region of the trade-winds, if the observer finds himself within its borders in the semicircle exposed to the winds, he ought to apply the ordinary rules, not to the wind that he experiences, but to that wind which, conjoined with the known trade-wind of that region, would give as its resultant the wind actually observed by him, both in direction and force. If we obtain graphically two distinct determinations of the centre, we can, if there is occasion to do so, correct this first approximation by introducing therein the velocity of translation of the centre of the cyclone or of the vessel."—6 *B*, LXXXI., 64.

DISTRIBUTION OF ATMOSPHERIC PRESSURE.

One of the most important meteorological publications of the year consists in that by Rikatcheff on the distribution of atmospheric pressure in European Russia. Having access to all the original documents, and having himself visited many Russian stations in order to secure perfect accuracy of instruments, Rikatcheff has been in a favorable position to give us the very valuable memoir which he has succeeded in compiling. The results of his work are given in the shape of a series of tables and charts, showing the distribution of pressure throughout Russia and the neighboring countries. In concluding his work, he says that there are still wanting the necessary data in order to use some half-dozen stations for which observations are at hand. But, apart from these, the charts of isobars which he gives represent very approximately the distribution of pressure for each month and for the whole year. According to these, by simple interpolation, the mean height of the barometer for any given point of Eastern Russia can be obtained with an accuracy of about one millimeter; and for Western Russia with an accuracy of one fifth of a millimeter. There is no successful attempt at an explanation of the low barometer in Northern Europe, and the author appears to be quite in ignorance of the theoretical works of Ferrel on this subject.—*Vienna Zeitschrift für Meteorologie*, 1875, 290.

THE EUROPEAN DROUGHT OF 1875.

The period of great drought, which lasted from February to April, 1875, in Europe, has been treated of by M. Lancaster, aid at the Royal Observatory of Brussels, who states that this period merits our attention. The rainfall during these three months has never, since 1833, been so small as during this year. The mean of the forty-two years of observations at Brussels gives for the three months 144 millimeters, while the height for 1875 is only 46 millimeters, or less than one third of the normal height. The pressure of the air has generally been high. The temperature has been subject to considerable variations, having been on the whole slightly below the average. The wind has presented the most interesting phenomena; the predominance of northern currents during March and April is especially remarkable. The drought extended even to the middle of June, although by that time a little water had fallen.—*Bullet. Acad. Roy. de Belgique*, 1875.

GLAISHER'S OBSERVATIONS OF MOISTURE IN THE ATMOSPHERE.

In the annual memoir at the opening of the Gymnasium at Sondershausen, the Director, Dr. Kieser, in an essay on the moisture in the atmosphere, states that he has carefully computed the extensive series of observations made by Glaisher in reference to the absolute and relative humidity at different altitudes. His results are presented in tables, showing the state of the atmosphere at every one hundred meters from the earth's surface up to a height of six thousand meters. He concludes, first, that it is demonstrated that the absolute humidity diminishes with the altitude, although exceptions are not uncommon; second, that therefore the surfaces imagined to be drawn through the atmosphere defining the regions of equal quantities of vapor have a wave shape, depending upon purely local circumstances; third, the quantity of vapor is different at the same altitude in different months; fourth, the density of the vapor diminishes much more quickly than the density of the air as we ascend. Thus the density at five thousand meters is about half of that at the surface of the earth, while the quantity of moisture at that altitude is, during August, from a fourth to a fifth, in September an eighth, and in April less than a tenth of that observed at the surface of the earth; fifth, at altitudes of six or seven thousand meters the absolute humidity is very small throughout the year, and less than one grain of vapor is to be credited to every cubic meter of air; but at the greatest altitudes that have been reached there has been found no perfectly dry air. Thus the relative humidity increases as we ascend from the earth's surface until we reach the level of complete saturation, but above the clouds the diminution of relative humidity diminishes suddenly. The ordinary condition of the atmosphere appears to be that of successive layers of moist and dry air. — *Gymnasial Programme, Sondershausen*, 1874.

ON THE RAINFALL AND EVAPORATION IN INDIA.

In a memoir by A. R. Binnie on the Magpur water-works, he gives some details with reference to the rainfall and the drainage at Magpur. This city is situated in latitude 21° north, longitude 79° east, at an elevation of about 1000 feet above the sea-level. The average rainfall for the nineteen years from 1851 to 1873 was 40.7 inches, of which 37.5 inches fell during the monsoon months from June to the middle of October. Although the general fluctuation of rainfall in India is similar to that in other parts of the world, yet it has certain well-marked peculiarities, the first of which is that the greater part of the annual rainfall is confined to a few months during the southwest or southeast monsoons; second, the greater part of the year is almost rainless; and, third, during the wet months the rainfall is much more intense than in temperate countries. In the most violent showers that have been noticed in that place the rain fell at the rate of 4.7 inches per hour. To determine the quantity evaporated from the surface of the ground is a matter of difficulty; but Mr. Binnie attempted, by careful observation of the level of the water in the receiving-basin during the dry season, and by comparing the result with the existing meteorological circumstances, to estimate the amount. During that period in which no water ran into the basin, the quantity in the latter diminished, in 242 days, to the extent of seven feet.

The diminution varied from 0.045 to 0.024 of a foot per day. The fluctuation of the rainfall year by year is quite large, and so distributed that on the average sixteen periods of great and little rainfall may be anticipated in every hundred years. Since it has been, during the past few years, suggested that the periods of fluctuation of the spots on the sun's disk bear a relation to the fluctuations of rainfall, similar to those which have been demonstrated in the case of terrestrial magnetism, Mr. Binnie has sought to test the truth of this statement by making a comparison between the fluctuations of the rainfall at fourteen places and the solar-spot periods from Schawbe's observations; but no satisfactory result or accurate deductions could be drawn from this test.—*Journal Institution Civil Engineers.*

ON THE THEORY OF HAIL.

Renou having proposed some objections to the theory of the formation of hail which Faye has recently had occasion to develop in connection with his theories relating to storms, he has replied to Renou, to the effect that hailstones are, in general, formed by successive accretions of coatings of ice, which latter are due to the cooling of the air to a point below its dew-point and below the freezing-point. Admitting that the nucleus may have a very low temperature, the same, viz., as that of cirrus clouds, it is easy to see that in virtue of this low temperature it will congeal around it a thin layer of transparent ice, and that, if the physical and mechanical conditions where it is remain the same, the hailstone will be kept at a temperature in the neighborhood of the freezing-point, and will, by the consolidation of the thin envelope and evolution of heat, no longer continue to grow, but need again to be cooled. The thickness of the shell thus formed after any one exposure to the moist air can not exceed one twelfth of the diameter of the nucleus.—6 *B*, LXXXI., 513.

RAINFALL OF BOHEMIA.

Among the recent monographs upon meteorological specialties, we notice a memoir by Professor Studnicke, read before the Bohemian Scientific Association of Prague, on the rainfall of Bohemia. The climatology of Bohemia has been most exhaustively investigated by Kreil in his work of that title, published in 1865; but in the matter of rainfall Studnicke has had special opportunities which have enabled him, to say nothing of the lapse of the past ten years, to present the fullest particulars and material. Thirty-eight stations were indeed represented in the memoir of Sonklar on the hyetography of Austria; he was, however, unable, even with this number of stations, to properly represent the southeastern portion of Bohemia. The gaps that were necessarily found in Sonklar's and Kreil's works have been filled up by Studnicke, who was three years ago put in charge of the meteorological section of the committee for the scientific survey of Bohemia, and who has been instrumental in adding about fifty new stations to those already existing. Especial study was made in the neighborhood of Prague, where four new stations were established, in order to elucidate the differences in the records of the older observations.—*Sitzb. K. Böhm. Gesellschaft*, 1874, 62.

MOISTURE IN THE ATMOSPHERE.

Mariè Davy states that there is kept in active service in the meteorological observatory at Mont-souris a collection of apparatus for investigating, in a general way, certain physical problems of the atmosphere, especially the quantity of aqueous vapor contained therein. The apparatus consists principally of a large telescope, with silvered objective and a photometric ocular. This ocular consists of a Foucault polarizing prism, behind which is placed a double-refracting analyzer movable about the centre of a graduated circle. By the use of this apparatus we measure the ratio of the intensity of the light given from the sun, and from any part of the atmosphere in its immediate neighborhood; this ratio varies with the state of the sky. A similar operation would give the measure of the apparent intensity of the solar spots. A second telescope of smaller dimensions is mounted equatorially. Its objective is uncovered, and its ocular is similar to the preceding. A disk of white enamel is fixed horizontally on a pillar; at the side of the disk is found a smaller one of copper, which projects its shadow upon the enameled disk when illuminated by the sun. This shaded circle is then only lighted by the diffused light of the sky, while the neighboring parts receive also the direct rays of the sun. The telescope previously described, or the photometer, gives then the ratio of the intensity of the two lights. Some white disks with black centres placed at various distances give with precision the degree of transparency of the air in day-time. The transparency of the sky during the night can also be found by the same instrument; but the results differ according as the moon is or is not above the horizon. The thermo-electric actinometer of Dessaine has also been modified in its applications by Mariè Davy. The cyanometer of Arago is also made use of.—*Bulletin Mensuel Observatoire de Mont Souris*, 1875, 129.

THE OBSERVATION OF POLAR BANDS.

The *Wochenschrift*, published for so many years by Dr. Heis, of Münster, has lately been transferred to the editorship of Dr. Herman J. Klein, of Cologne, well known to lovers of astronomy by his numerous popular essays. In his hands its interest will not fail of being maintained. Two recent articles by him are especially worthy of notice, one on the importance of observations of that form of clouds ordinarily known as polar bands, which have acquired a new interest owing to the observations and theories of Prestel and Hildebrandsson. In another article Dr. Klein calls attention to the project long since made by Dr. Falb of using the asteroids as a medium for determining the brightness of the faintest fixed stars.—*Klein's Wochenschrift*, 1875.

TIME OF SETTING SELF-REGISTERING INSTRUMENTS.

In the report of the meteorological section of the Leicester Literary and Philosophical Society, we learn that the time of setting the self-registering instruments has been altered from 9 A.M. to 9 P.M. This alteration has been made in consequence of the recommendation of the Vienna Congress, which has been adopted by the official and by all the principal private observatories of England. A new and more complete graphic method has also been adopted for displaying the daily readings of the meteorological instruments. By this method a whole month's daily readings are now exhibited in tabular form on a single sheet.—*Leicester Literary and Philosophical Society's Report*, 1875.

ON THE WET AND DRY BULB THERMOMETER.

One of the most serious defects in the use of the August Psychrometer, or the wet and dry bulb thermometer, is due to the fact that the radiation from surrounding objects affects the covered thermometer quite differently from its effect upon the naked. In order to remedy this defect, Overbeck, of Batavia, proposes to place the instrument within a shelter formed of thin upright sheets of metal, so that the direct rays of the sun can not strike the instrument. Metal has some advantages over the wooden screens usually employed.—*Tijdschrift Voor Nederlandsch Indie, Batavia*, 1874, 120.

PERIODICITY OF THE AURORA.

Professor Fritz, whose great catalogue of all known auroras was published in 1873, has recently communicated to the Natural History Society of Zurich an investigation into the relative periodicity of auroras and solar spots. He finds the differences between the years of greatest auroral and sun-spot frequency are sometimes positive and sometimes negative; but in general the maximum of the auroras occurs seven tenths of a year after the maximum of sun-spots, while the minimum of auroras occur three tenths of a year before the minimum of the sun-spots. These differences, however, are too uncertain to be spoken of as a definite law. As regards the greater period of 55 years, he concludes that for the present we can not improve upon the determination made by himself in 1865, when he showed that this periodicity could be best represented by assuming that it coincided with five of Wolf's 11-year periods, or 55.55 years. He considers it also probable that there is a still longer period of 222 years in auroras, which, of course, we are unable to detect in the solar spots for want of observations.—*Vienna Zeitschrift für Meteorologie*, X., 317.

THE NEW PHYSICAL OBSERVATORY NEAR ST. PETERSBURG.

Dr. Wild, of St. Petersburg, Director of the Physical Central Observatory, gives an account of the establishment near St. Petersburg, at the well-known summer resort Pavlosk, of an auxiliary observatory, at which it is hoped numerous investigations may be carried on which could not be brought to successful conclusion at the central office in St. Petersburg. This new physical observatory consists of a principal stone building, with a high tower for anemometric observations, and contains physical, chemical, and photometric observatories, workshops, etc. A magnetic apparatus of the most complete nature is established in a subterranean cellar room. Dwellings for the officials will also be erected. The entire cost will not be far from one hundred thousand dollars in gold. The erection of the new building will begin in the spring of 1876. The annual appropriation for the institution will amount to thirteen thousand dollars, while the similar appropriation for the central institution at St. Petersburg, which amounts to thirty-six thousand dollars, will not be diminished, in order that it may carry on to completion the great works already begun.—*Vienna Zeitschrift für Meteorologie*, X., 293.

THE HURRICANE OF SEPTEMBER 9TH TO 17TH, 1875.

The hurricane of September 9th to 17th is described in the *Monthly Weather Review* of the Army Signal-office as one of the most violent that has occurred since the establishment of the Weather Bureau. It was first observed in latitude 13° north, longitude 17° east from Washington, and appears to have originated to the east of Barbadoes. Passing thence toward the west-northwest, its path curved around, striking the coast of Texas, whence it moved toward the northeast until it disappeared in latitude 38° north, longitude 6° east. On the 14th the morning reports announced that the centre of the storm had already passed to the westward of Key West and Havana. Very perfect records of the changes in the barometer and winds have been preserved at the Galveston and Indianola stations, at which place it was at its height on the 16th and 17th. The lowest barometers were, at Galveston 29.04, and Indianola 28.90. The maximum velocity of the wind at Galveston was sixty miles per hour, from the southwest and west. The maximum at Indianola was eighty-eight miles per hour, from the northeast, as registered by the anemometer. This instrument having however been destroyed by the continued gale, it was estimated that the velocity subsequently attained one hundred miles per hour.

The extreme severity of the storm seems to have been felt on the coast of Texas. In its subsequent course it extended over a larger area, and seems to have produced heavy gales on the Jersey coast, and to have had some connection with the violent storms which prevailed on the North Atlantic Ocean to the north of Great Britain from the 26th to the 29th of September. The heavy rains that accompanied the storm during its prevalence over the Gulf of Mexico contributed to the large excess of precipitation which prevailed in the Gulf States for the month of September.—*Monthly Weather Review for September*, 1875.

THE DIRECTION OF CIRRUS CLOUDS.

The movement of the cirrus clouds has been the subject of study by Hildebrandsson, of Upsala, who hopes thereby to deduce some results relative to the ascending and descending movements of the atmosphere above the regions of high and low barometer. The observations of Clement Ley show that the cirrus clouds move from areas of minimum toward areas of maximum pressure, and Hildebrandsson has endeavored to extend this interesting generalization over a wider field. He states, in fact, that a general study of the clouds over the whole of Europe shows him that while the air on the earth's surface moves in spiral curves, inward, toward low barometer, the air at a high altitude simultaneously moves outward. The upper winds, therefore, constantly make an angle toward the right with the lower winds. This demonstration was in 1871 also made by Abbe for the United States, and may probably now be considered as a general rule, applicable throughout the world. It is important to notice that the same conclusion was arrived at deductively by Ferrel in 1857, and is fairly stated in his great work on the motions of bodies on the earth's surface.

THE TEMPERATURE OF THE EARTH.

The interest which attaches to careful observations of the temperature of the earth suggests that the apparatus which is used in Germany should be better known in this country, in order that, when practicable, it may be introduced here. The following is a description of it as used by observers in Hungary. In its general outlines it does not differ from that

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recommended by Lamont. It consists principally of a rectangular tube buried permanently in the earth, within which five rectangular prisms of wood are placed, one above the other, at different depths in the ground, and which, by a simple arrangement, can be easily and quickly drawn up. Each of these tubes contains a thermometer, and there is a hole in the side of the main tube, opposite to the bulb of the thermometer, where the wood-work is cut away, and the opening closed by a plate of thin sheet copper, whose temperature may be presumed to be the same as that of the adjacent ground. The depths at which the thermometers' bulbs remain are 4, 8, 12, 16, and 20 feet. Schenzl, as the result of observations made during eight years, finds that the time required for heat to penetrate to a depth of one meter is, on the average, 21 days.

THE INTENSITY OF TWILIGHT.

Mr. Williams, a student of the Massachusetts Institute of Technology, has made some observations to determine the quantity of light reflected during the hours of twilight, when the sun is at different distances below the horizon. The photometer employed was a slight modification of the Bunsen photometer. The illuminated disk was exposed on one side to the light from a standard candle, and on the other side to the light admitted from the sky.—*Proceedings Am. Acad. Arts and Sciences*, 1875, 421.

ON THE QUANTITY OF LIGHT REFLECTED BY THE SKY IN THE DAYTIME.

The quantity of light reflected by the sky at any given distance from the sun has long been a subject of meteorological observation, the first rude attempt at its measurement being made by the use of Saussure's cyanometer. Some elaborate investigations have been pursued for a long time at the Mont-souris Observatory. An interesting investigation of the question by a simple photometric apparatus has recently been published by Crosby as a student under Professor Pickering of the Institute of Technology at Boston. His objects were to determine, first, the absolute amount of light received from the sky at different distances from the sun, and second, to ascertain the law of diminution of light with increasing angular distance from the sun. The method pursued was to so adjust the apparatus that an image of the sun would fall upon the Bunsen disk of the photometer, and then to measure the intensity of the light at regular intervals of time, as the sun receded from the portion of the sky whence the light was received. Observations were made on days both hazy and clear; and notwithstanding the great differences in the intensity of the light, it was found that it was proportional to some power of the sun's angular distance. This power was approximately for hazy days=1.04, but for the clearest days =1.21.—*Proceedings Am. Acad. Arts and Sciences*, 1875, 425.

WIND VELOCITY AND THE BAROMETRIC GRADIENT.

The term barometric gradient was introduced into meteorology some years ago by an English engineer to express the rate at which the barometric pressure varies as we pass from one part of the country to another. It has long been adopted by Europeans as a rule in weather forecasts, that rapid changes of the pressure or steep barometric gradients will be followed by strong winds blowing nearly at right angles to the direction of the gradient. The explanation of this well-established generalization was partially given some years ago by Professor Ferrel of the United States Coast Survey; and his views have been adopted of late years by most European meteorologists who have studied dynamic laws. According to Professor Ferrel, whenever, from any cause whatever, an influx of air takes place from the surrounding regions toward a central spot, a gyratory motion must at once be set up, as illustrated in the whirls at the corners of the streets and in the tornadoes and hurricanes of the tropics. A very slight disturbance in the equilibrium of the atmosphere, such as would scarcely be shown by any but an unusually exact barometer, suffices to initiate the inflow of air and to give rise to the gyrations. If the earth were not revolving upon its axis these gyrations would take place in either direction, viz., either with or contrary to the movements of the hands of a watch; but owing to the great power of the immense velocity with which the earth revolves on its axis daily, the direction of all gyratory movements in the northern hemisphere is regulated thereby, being in fact uniformly contrary to the movement of the hands of the watch. It is to the centrifugal force due to this gyratory movement, by reason of which the air may be considered as revolving not only about the centre of the hurricane, but also about the earth's polar axis, that Professor Ferrel attributes the greater part of the depression of the barometer which is observed at the centre of the storm. The amount of this depression can be quite exactly calculated by the formula given by him. Not only does the air revolve about, but it also preserves its tendency to move inward toward the centre of lowest pressure near which it rises, and then the upper region of the atmosphere continues its gyratory movement, but flows outward, gradually descending until it meets the earth again. Professor Ferrel has been successful in explaining satisfactorily, by one single formula, and in grouping together under one common point of view, the phenomena of tornadoes and waterspouts and extensive hurricanes. His formula, after allowing for the density of water, applies also to the movements of the ocean; and by means of it he is able to compute the gradient of sea-level due to the deflecting force of the earth's rotation, showing that, for instance, we obtain about six tenths of a foot as the depression in sea-level due to a change in position of a hundred miles on a parallel of 30°, the sea-level being highest in the middle of the gyration, that is to say, in the central portions of the Atlantic and Pacific Oceans.—4 *D*, *November*, 1874.

THE MECHANICAL THEORY OF CYCLONES.

Among the treatises on the mechanical theory of the movements of air in revolving storms, both hurricanes and tornadoes, but few have such practical value as that of Colding, published in Danish in 1871, translations of which have recently been prepared by Hann, of Vienna, and Abbe, of Washington, by means of which the English-reading public is introduced to a series of novel investigations into the flow of liquids, which forms a very acceptable addition to our knowledge of the subject. According to Colding, the laws governing the movement of water may, with certain restrictions, be applied to the movement of the air; and after having, as an engineer, for many years successfully studied the currents of rivers and oceans, Mr. Colding has applied his results to the study of a few hurricanes. The mathematical formulæ by which he has endeavored to show the relation between the velocity and pressure of the air and the dimensions of the whirlwind are apparently deduced in a not very rigorous, but sufficiently approximate manner. On applying them to the actual observations taken in connection with the hurricane of 1837 (the so-called Antiguan hurricane), and also to the hurricane of the 21st of August, 1871, he finds that the formula represents the observations with a degree of accuracy probably within the errors to which the observations themselves are likely to be subject. The simple principle according to which he is able to calculate the nature of the final shape of the surface which is shown for instance whenever water is allowed to flow out of a bowl through a central hole, consists in this, viz., that when the rotation is once established in the water, each particle describes a circle about the central axis, whose radius is such that the pressure of the water above the moving particle exactly counterbalances the centrifugal force due to its circular rotation. In the case of the atmosphere we have, instead of a well-defined surface, a series of surfaces of equal pressure, and the centrifugal force due to the circular movement around the centre of the hurricane is counterbalanced by the pressure of the atmosphere at that point. Unfortunately, Mr. Colding seems not to have taken account of the force due to the rotation of the earth on its axis. His equations, therefore, apply to tornadoes and to the central portions of hurricanes better than they do to the exterior portions of large storms.—*Zeitsch. für Meteorologie, May*, 1875, 133.

THE MONSOON.

In the magnificent volume of magnetic observations at Trevandrum, in Southern India, Mr. Broun gives the following interesting account of the advent of the monsoon. He was stationed at certain times at an auxiliary observatory on the peak known to the natives as Agustia, whose altitude is over 6000 feet, and which from time immemorial had been superstitiously regarded by the Hindoos as the residence of Agustia, a savant, physician, philologist, and theologian, whose principles were celebrated for their purity. Mr. Broun states that during his visits to this peak he made daily notes of the appearance of the clouds and sky, and that there is no place in India where the magnificent phenomena which precede the bursting of the monsoon can be seen and studied with more ease. The peak in question is one conspicuous for its height and its isolation. As seen from Trevandrum, it rises in the form of a sharp-pointed cone. On the west it is a precipitous wall for nearly two thousand feet, and on the east it descends at an angle of about 60° with the horizon. Standing on its summit, for a month or more before the final crash of the tempest, the whole operations of the great atmospheric laboratory are developed at one's feet, while the summit of the mountain itself is rarely visited by the storms which rage over its western flanks. On the occasion of his first ascent, Mr. Broun states that, arriving at the summit, he saw to the west Trevandrum lying on the low lands, the intermediate plains spotted with clouds, shadows, and bright sunshine. A thick stratum of clouds, about on his own level, was, however, coming rapidly toward him, and in five minutes after dashed like a hurricane on the cliff below, burying the summit in a dull, gray light and a wet mist. Within the next two days they had twelve inches of rain, and it was evident that the monsoon had set in. On a subsequent visit, made during the dry season, he had ample occasion to study the gradual approach of the monsoon, and in general states that in the mornings chains of finely formed cumuli seemed to rest over the eastern horizon of Malabar and Coromandel. These clouds were irregularly distributed over the country, their shadows projected vertically at noontime, spotting and checking the plains between the sea and the mountain. Early in the morning the vapors began to rise near the western precipices, the clouds accumulated and sought to escape by the lowest passes into the eastern valleys, but were opposed by a repulsive influence, although no breath of air was felt. At last, after noon, in mighty masses it ascended, crowned with cirrus cloud, which spread eastward like an immense parasol overhead. Then the lightning began to play from cloud to cloud, followed by thunder, and drenching rain in the forests below. After one or more hours, according to the distance from the monsoon, the clouds left the mountains, retreated westward, and then disappeared, the sun shone out from the western sea, the stars sparkled in all their beauty, and the next morning again brought the chain of clouds on the horizon. As the time for the monsoon drew near the cloud-masses with more and more energy endeavored to pass the mountains eastward. Sometimes two such masses presented themselves, one creeping up the eastern valley and the other entering the valley from the west. Day by day the returning clouds made a little further progress. At length on the decisive day, driven on by a giant force, they rose to the tops of the mountains, and poured over their walls into the eastern hills like steam from a great caldron. They plunged first downward, and then curling upward disappeared in the hotter eastern air. The storm with deluges of rain swept across the mountain, and the monsoon reigned over the low lands of Malabar.—*Trevandrum Observations*, I., 517.

ORIGIN OF COLD WAVES OF AIR.

Dr. Klein, in reference to the use of daily weather reports, states that in Europe as in America, in all cases, the reports of the weather westward of a given station are of the greatest importance, while reports from stations to the east are, on the average, of minor importance in making weather predictions. A southerly wind in the region of Ireland, Scotland, or Norway indicates the approaching side of an area of low barometer. It is therefore a sign of a coming change in the weather. A northerly wind in those regions indicates, for Germany, that the pressure of the air from the ocean is high, and can be considered as a sign of steady pleasant weather. Irregular changes of atmospheric pressure and of the winds are extremely slight in Eastern Asia, and the cold of winter when once commenced continues uninterruptedly in Eastern Siberia with a permanent high barometer. The reason of this is found in the existence of the great mountain chains of Asia. The region of high barometer is generally separated from oceans and from equatorial regions by these lofty chains of mountains. The coldest and densest stratum of air can therefore not flow away toward the sea. Its only escape is found at points like Jakutsk, where it passes over land 3000 feet above the ocean. Thus, throughout the whole interior of Asia, the lower stratum of air remains quite cold and heavy, until the summer sun, heating the surface of the earth, stirs up the atmosphere, very much as water boils in a vessel over the fire. That which takes place in Asia is repeated in a much less intense degree in America. The area of the greatest cold on this continent is not prevented by any range of mountains from extending southward and eastward, but is only hemmed in on the west by the Rocky Mountains. Thus while the Pacific coast is protected from an overflow of very cold air, the whole eastern portion of America becomes peculiarly subject to it.—7 *C*, II., 9.

DALTON'S LAW, AND THE CONSTITUTION OF THE ATMOSPHERE.

It is well known that the famous law of Dalton, with reference to the diffusion and independent existence of aqueous vapor in the atmosphere has exerted a very strong influence in moulding the views of meteorologists as to the method by which this portion of the atmosphere operates in modifying meteorological phenomena. Of late years, however, very strong suspicions have existed as to the propriety of carrying Dalton's views to the extreme that has been maintained by many. In fact, so early as 1840, Espy distinctly controverted them. Of late, Hildebrandsson, Hann, and especially Stefan, have more correctly explained the limitations within which Dalton's laws may be applied. According to the latter, these obtain in the case of a mixture of gases only under conditions of static equilibrium, and do not hold when these are in relative motion. Since the vapor of water in the air, in consequence of its continual evaporation and condensation, is always in movement, it does not conform to Dalton's laws. The permanent gases of the atmosphere, especially oxygen and nitrogen, which retain in general the same proportions, are in equilibrium, and do form atmospheres independent of each other, according to Dalton's laws. It necessarily follows that the percentage of dense oxygen must be smaller as we ascend in the air; and, in fact, chemical analysis gives this result.—19 *C*, VIII., 90.

THE TEMPERATURE OF THE AIR.

One of the most difficult problems in all matters relating to the atmosphere consists in the determination of the true temperature of the air; and the errors in these determinations affect very sensibly both astronomical, meteorological, and hypsometric labors. Professor Plantamour was among the first to show that observations of the barometer taken simultaneously at two distinct stations ought to enable us by calculation to arrive at the average temperature of the intervening atmosphere. Among those who have lately applied this method is Mr. Schott of the Coast Survey, who has, from observations made about fifty miles northwest of San Francisco, calculated the temperature of the air between two stations occupied by Mr. Davidson. As the results of these studies, it appears that the average temperature of the air between two stations differing 2000 feet in altitude remained sensibly constant throughout the entire day, as though the sun's rays passed through it without appreciably heating it; while, on the other hand, the thermometer at the two stations respectively rose to a maximum at 1 P.M., and fell to a minimum in the morning and evening. The daily variations of temperature seem, therefore, to be confined mainly to the layer of air in close proximity to the earth's surface. The corrections to be applied to the observed thermometers, in order to obtain the true temperature of the air, varied regularly throughout the day, and are decidedly larger than those obtained by Professor Plantamour at Geneva. M. Schott, in explanation of this phenomenon, suggests that probably the 20 or 30 per cent. of total solar radiation which is absorbed by the atmosphere is consumed in the processes of expansion and evaporation; and thus gives no sensible heat.—*Coast Survey Report, Appendix* XI., 1871.

THE UPPER CURRENTS OF THE ATMOSPHERE.

The upper currents have been much neglected by meteorologists until recent times, when the extensive weather-maps published in Europe and America have enabled proper attention to be given to their study. Some of the important laws relating to the movements of the cirrus clouds were apparently suspected by Redfield, and were in a general way predicted by Ferrel; but extended observations and deductions are due principally to Clement Ley (1872), and more recently to Hildebrandsson, the Director of the Meteorological Bureau of Sweden. This gentleman states that in December, 1873, he addressed letters to many observers in Europe, soliciting accurate observations on the movements of the cirrus clouds. All the observations were carefully entered by him in the weather-charts of Europe, and compared with the observed direction of the lower clouds, as well as the course of the isobarometric lines. From the entire series of observations accumulated in three years, Mr. Hildebrandsson gives his conclusions as follows: Near the centre of a barometric depression the upper currents move in a direction very nearly parallel to the isobars and to the lower currents; but in proportion as we go from the centre of low pressure they move outward, and deviate to the right of the lower clouds. Within regions of maximum barometric pressure the upper clouds converge toward the centre, cutting the isobars very nearly at right angles. The figures prove clearly that the upper currents of the atmosphere move from the barometric minima, and converge toward the maxima.

In respect to the arrangement of parallel bands of cirrus clouds, our author states that he has inserted upon his charts 171 observations, and finds that the bands of cirri are, within the regions of maximum pressure, generally arranged in directions very nearly perpendicular to the isobars, but in the regions of minimum pressure they are sensibly parallel to the isobars. It follows from his investigation that the air must necessarily be ascending in the region of low barometer, and that, when arrived at a great height above the earth, it removes from this region of low pressure and, spreading uniformly out over the regions of maximum pressure, gradually falls toward the earth in descending currents. In this manner there is effected a continual vertical circulation between the surface of the earth and the upper limits of the atmosphere. The principal agent in this circulation is the difference in temperature and moisture between the lower and the upper regions of the atmosphere—differences which exceed even that between the equator and the poles. Carrying out this idea, Hildebrandsson concludes that the cold experienced at the surface of the earth during areas of high pressure comes from above, being brought down by the descending atmosphere, and explains thereby the anomalous daily period in the determinations of the altitudes by the barometer. The conclusion of his memoir, expressing the hope that observations of cirrus clouds will in the future be more thoroughly made in connection with weather predictions, has been already, we believe, anticipated, so far as the action of the Weather Bureau of the Army Signal-office is concerned, since its tri-daily maps have shown the movements of cirri ever since 1871, in which year also Professor Abbe announced for America laws precisely the same as those that Hildebrandsson has now deduced for Europe.—*Essai sur les Courants Supérieurs*, 1875.

A VERY DELICATE BAROMETER.

An ingenious device has been constructed by Mendelef, which shows the slightest variations of pressure by means of a small U-shaped tube containing petroleum-oil. One end of this tube is closed, and contains a certain volume of dry air maintained at a constant temperature, while the other end is open to the air. The instrument being accurately adjusted by means of a mercurial plunger connected with the bottom of the U-shaped tube, so that the petroleum is exactly on a level in the two branches of the tube, it is found to be so extremely sensitive that the slightest variation of the atmospheric pressure is shown by the alteration of the relative level, and the amount of this alteration can be measured with the greatest precision.

CONVENIENT FORM OF MERCURIAL BAROMETER.

A mercurial barometer especially convenient for travelers has been invented by Staff Commander George of the British Marine, and is described by Dr. Gurt, according to whom its convenience as well as its excellence consists essentially in the fact that it is filled anew at every station at which it is to be used. The great objection to filling the barometer tube consists in the difficulty of removing every particle of air from the quicksilver in the tube, and securing a perfect vacuum. The operation of boiling mercury is both difficult and hazardous unless the method adopted by Wild be employed. Commander George's method of removing every bubble of air consists in first introducing into the tube a string of cat-gut, on the end of which a feather is fastened, which should reach to the bottom of the tube. The tube is then filled to one third of its height with quicksilver, which is then set in rotation by rapidly spinning the cat-gut between the fingers, while at the same time the string and feather are slowly drawn up. By this means whatever air adheres to the sides of the tube, or is carried down by the quicksilver, is completely displaced and rises to the surface. More mercury is then poured in, and the operation twice repeated, until the tube is filled. By this means a vacuum is always secured without boiling the mercury in the tube, as is shown by a comparison with the most carefully prepared standard barometers. When the barometer is to be transported, the tube is emptied of mercury, which latter may be carried either in the cistern or in a separate vessel.—*Verhandl. Naturhist. Vereins, Bonn*, XXXI., 266.

THE TEMPERATURE WITHIN THE GREAT GEYSER OF ICELAND.

Mr. Robert Walker communicates to the Royal Society of Edinburgh some measurements made in August, 1874, at the Great Geyser of Iceland, which he visited, although his stay was only for a few hours. During that time he was able to make observations of temperature at twelve different depths, varying from 0 to 77 feet; and the temperatures at these depths increased from 187° at the top to 257° at the bottom, whereas the boiling-points, as calculated by him, would have been respectively 210° and 278° Fahr. He states that his results confirm very remarkably those of Professor Bunsen, obtained during ten days in July, 1846. The difficulty of reaching the place at all will hinder, he thinks, any one from carrying thither accurate apparatus for a more complete series of observations than he was able to make. In a general way he finds, as did Bunsen, that the temperature of the water nowhere reaches the calculated boiling-point; but the deviations therefrom seem to have been far greater in 1846 than in 1874.

No theory of internal caldrons filled in succession with steam and water seems at all consistent with observed phenomena.—*Proc. of the Royal Society of Edinburgh*, VIII., 514.

AWARD TO THE ARMY SIGNAL SERVICE.

In noticing the fact that the recent Geographical Congress at Paris awarded to the United States Army Signal Service a letter of merit as the highest testimonial, we will also call attention to an admirable *résumé* by Angot of the organization and labors of the Army Weather Bureau. In closing his review, he states that independently of the usefulness of the Signal Service in its own country, "we see that it has a still higher claim upon the recognition of all meteorologists by its 'International Bulletin.' This publication is made on so generous a basis, and distributed with such liberality, that it would suffice of itself to place the Signal Service in the first rank of all the meteorological institutions of the entire world."

"On the occasion therefore of the recent Geographical Exposition, the International Jury was constrained to decree to it its highest award, associating it with two other equally remarkable institutions, whose titles are, however, slightly different, viz., the Meteorological Office of London, and the Meteorological Institute of Utrecht; while these latter two represent the scientific, the Signal Service seeks only the practical, but is also useful to both — to America by its weather predictions and its daily labors, and to the rest of the world by its publications."—8 *B*, *April* 22, 1876, 401.

THE CLIMATE PRECEDING THE GLACIAL EPOCH.

As the result of study into glacial phenomena in Upper Bavaria, Zittel concludes it to be proved that the glacial epoch was preceded by a period of extensive floods, during which immense masses of movable material filled up the inequalities of the valleys and ravines previously excavated in the tertiary deposits, and thus afforded an even surface for the glaciers that were to follow.—*Sitzb. K.-B. Acad. München*, IV., 282.

TABLE FOR COMPUTATION OF RELATIVE HUMIDITY.

In the annual report of the commission charged with the maintenance of the meteorological observatory at the Pic du Midi de Bigorre, a convenient table is given by Hatier, one of the members of the commission, for computing the relative humidity from the indications of the wet and dry bulb thermometer, when the atmospheric pressure at the place of observation differs considerably from thirty inches. Most observers are either ignorant of the fact that the ordinary tables for computing relative humidity are applicable only for stations at or near the sea-level, or else they neglect to make the necessary correction for altitude, owing to the labor of the computation. The table given by Hatier is perfectly general in its applicability, and enables one to compute the relative humidity, no matter what the barometric pressure may be, and is worthy the adoption of American observers.—*Rés. Obs. du Pic du Midi*, p. 21.

IMPROVEMENT IN ANEROIDS.

Hon. Ralph Abercrombie notes that a decided improvement in aneroid barometers consists in jeweling the ends of the arbor of the index hand like the ordinary pivots of a watch, and making the hands work underneath the cap, instead of in the usual manner. He recommends conical pivots as preferable to straight ones.—*Quar. Jour. Brit. Met. Soc.* 1876, 87.

THE CLIMATE AND TREES OF SACRAMENTO BAY.

An interesting memoir on the distribution of forests and trees in the neighborhood of San Francisco is given by Dr. Cooper in the fifth volume of the Proceedings of the California Academy. He states that the most notable fact in botanical geography is the comparative scarcity of trees as compared with regions to the northward or southward, and, after a careful study of the subject, he concludes that the chief cause of this deficiency is the prevalence of strong winds, which throughout the dry season blow so steadily into the Golden Gate from the northwest, and are drawn by the ascent of hot currents far into the interior, following, generally, the course of the valleys upward from the bay of Sacramento. Where the west winds blow with sufficient force, the tree growth is limited to scattered groups on the eastern slopes of the hills. Elevation above the sea has less effect than would be expected. Trees that are fully developed in unexposed regions dwindle into shrubs in the exposed portions, assuming the aspect of trees stunted by the cold, as on mountain summits. Dryness, however, is still more influential than cold. The general course of the mountain ranges is nearly northwest. The wind strikes the southwest slopes obliquely, and the sun shines on the same slopes most intensely. These are the slopes that are almost every where destitute of trees, although they receive the greatest rainfall and the most fog. The winds act in two ways: first by their drying power, and second by their coolness; perhaps also by their influence in spreading fires during the dry seasons. The forests are chiefly most extensive on the northeastern mountain slopes.—*Proceedings of the California Academy of Science*, V., 286.

PERIODICITY OF HURRICANES.

In the March and April numbers of the *Revue Maritime et Coloniale*, Vice-Admiral Fleurcote de Langle examines the question of the periodicity of hurricanes throughout the globe; having reference especially to the influence of the sun and of the moon. He concludes that for a given latitude of the earth's surface we can, by knowing the positions of the sun and the moon, compute the probability of experiencing a hurricane on any given day. For this purpose he gives tables based upon a complete analysis of recorded hurricanes, the reliability and usefulness of which is, however, somewhat problematic.—*Revue Maritime et Coloniale*, 1876, 129.

CLOUDS AND WINDS AS OBSERVED FROM BALLOONS.

In some notes on the formation of clouds, Villeneuve states that when the sky is covered with nimbus or cumulus, one always meets on ascending in a balloon with winds moving either in a contrary direction, or crossing each other under variable angles, or if very nearly in the same direction, then with very different velocities; and these winds have very different temperatures. Second, when the sky is without clouds, or we see only cirrus, we find at all altitudes winds moving in the same direction, or, exceptionally, two winds in different directions, but having sensibly the same temperature. In explaining these phenomena, he lays down the rule that the thickness and the form of clouds are functions of three causes: first, the difference between the temperatures of two superposed currents of air; second, the relative velocity of one current over the other; third, the degree of humidity; and it can happen but rarely, he states, that two currents moving in different directions do not produce clouds at their surface of contact. This occurs, however, only when they are sensibly at the same temperature. He has observed this fact in north winds blowing above east winds; but never in the case of south winds blowing above north winds. Some aeronauts have observed four currents superposed and blowing in different directions. This condition is extremely favorable to the formation of rain. According to Villeneuve, if we could know the temperature of the winds which are superposed above our heads and their hygrometric state, we should be able to announce with certainty whether rain or cloudiness would ensue.—*L'Aéronaute, November,* 1875, 321.

HIPP'S ANEMOMETER.

A description of the anemometer recently invented by Mr. Hipp is given by him in the tenth volume of the Bulletin of the Scientific Society of Neuchatel. The object of this anemometer is to register at any distance whatever the velocity or the total movement of the air. It permits one to determine at any minute the velocity of the wind. The wind acts upon the ordinary Robinson atmospheric cups, and these can be placed at any distance from the registering apparatus, communicating with it by electric telegraph. Clock-work communicates a movement to the long band of paper destined to receive the register. Velocities as high as fifty miles an hour are registered on this band, but the apparatus can easily be enlarged to record the highest velocities that occur in hurricanes.—*Bulletin Soc. des Sciences Naturelles, Neuchâtel,* X., 189.

DUFOUR'S HYGROMETRIC STUDIES.

Dufour has presented to the Society Vaudoise a second memoir on hygrometric diffusion, in continuation of that published in 1874. The following is a general summary of his conclusions:

When a partition of porous earth separates two masses of air in different hygrometric states, there are produced two opposite and unequal currents of diffusion traversing the partition. The greater current flows from the dry to the humid air. The difference of the two currents depends principally upon the difference in tension of the vapor on the opposite sides of the partition. Temperature has little or no effect. Second. Hygrometric diffusion takes place through plates of marble five millimeters in thickness, homogeneous and compact, polished or not polished; but it is slower in this case than when traversing partitions of porous earth. Diffusion is observed also through gypsum, charcoal, and alabaster, being slowest in the latter case. Third. When a limited volume of air is inclosed in a vase, of which one side is a porous partition, there is produced and maintained between the interior of this vase and the surrounding air a difference of pressure, if the hygrometric conditions are different within and without. The difference of pressure is nearly independent of the thickness of the porous partition, and is attained in a space of time varying with the amount of surface of the partition. Fourth. The difference of pressure that the hygrometric diffusion is capable of producing and of maintaining depends, other things being equal, on the thickness of the partition. For porous earth, the possible differences of pressure are very nearly inversely proportional to the square roots of the thicknesses. Fifth. The current of diffusion attains its greatest velocity when the barometric pressure is the same on both sides of the partition, and is greatest when the thickness of the partition is least. Sixth. When the hygrometric diffusion has brought about a difference of pressure within and without the inclosure, the excess of volume of the prevailing current is diminished in proportion as the difference of pressure increases. This diminution is more rapid according as the partition is thinner.—*Bulletin Soc. Vaudoise, Lausanne*, 1875, 608.

THE SEVERE STORM OF MARCH 12, 1876.

The severest storm that has ever been observed at Brussels occurred on the 12th of March, 1876, on which occasion the barometer fell to a very low point and the wind acquired unequalled violence. Its maximum force, as measured by the pressure anemometer, was 144 kilogrammes per square meter. On account of the exceptional character of this storm, the director of the observatory, M. E. Quetelet, has presented to the Royal Academy of Belgium a special study of its history, development, and progress. Quetelet states that many documents relating to this storm still remain in the hands of Messrs. Buys Ballot and Scott, who are also occupied in the same study. His memoir is accompanied with a map showing the force of the wind and the barometric pressure at every hour during the day on which the storm occurred. The maximum violence of the wind was attained, as is usual in Europe, a few minutes before the minimum pressure occurred, when the direction of the wind was from west-southwest.—*Bulletin Acad. Roy. des Sciences, Bruxelles, 2d Series*, XLI., *April*, 1876.

BAROMETRIC PRESSURE DURING WINDS.

Montigny communicates to the Academy of Sciences of Belgium an investigation into the law of diminution of pressure in the atmospheric strata when the state of equilibrium is disturbed, especially under the influence of storms. His remarks are based principally upon observations made by him some years ago in order to determine the influence of winds upon barometric altitudes. Having distributed his observations into four classes according as they were made during the periods of high or low, rising or falling barometer, he draws the following results: First. Barometric altitudes measured under the influence of easterly winds are generally less than the true altitudes, and correspond very frequently to epochs of high barometer, and rarely to epochs of low barometer. Second. The altitudes under the influence of east winds are least when the wind is exactly east. Third. The altitudes calculated when west winds blow are generally superior to the true altitudes, and have most frequently been measured under the influence of storm-winds. When, however, the pressures are increasing, the west winds sometimes give especially low altitudes. Fourth. The number of storms with westerly winds is a maximum when the wind is directly west; to which point also correspond the greatest altitudes as computed by barometric observations. Now the theoretical laws, according to which altitudes are computed barometrically, are rigorously true only when the air is calm. We should then conclude that under the influence of storms the diminution of pressure in the layers of air is more rapid as we ascend vertically than when the air is calm; and, again, that this diminution is more rapid when the barometric pressure is diminishing under the influence of west winds; but when the atmospheric pressure is increasing during the prevalence of an east wind, barometric altitudes are less than the true altitudes; or the diminution of pressure in the successive strata of air is less rapid than when the air is perfectly calm.—*Bulletin Acad. Roy. des Sciences, Bruxelles*, 1876, 757.

CLIMATIC CHANGES IN SCOTLAND.

Mr. Buchan communicates to the Botanical Society of Edinburgh a short note on the bearing of meteorological records on the supposed change of climate in Scotland. He states that Mr. McNabb, in 1873, defended the popular theory that the climate of Scotland affords cooler summers and warmer winters than formerly, basing his support upon the facts deduced from vegetable phenomena. Mr. Buchan himself, however, examines the question solely with reference to the recorded monthly mean temperatures as observed since 1781, in two districts—one in the north and one in the south of Scotland. The records show plainly that, as regards temperature, the weather of December is subjected to large fluctuations, but there is no tendency to a permanent increase or decrease of temperature; and similarly with the temperature of July. Exceptionally warm and exceptionally cold months are distributed throughout the whole ninety-four years, in such a way as to show that no permanent change has taken place in the temperature of any month, or of the year. As an instance, however, of the remarkable fluctuations which occur, he adds that during the past seven years the temperature of July has been above its average, and that of December has been below the average. These variations are quite in the opposite direction to that required by the public belief.—*Transactions Botanical Society of Edinburgh*, 1874, 250.

THE ANEROID BAROMETER.

An excellent series of papers has been presented to the scientific society of Chemnitz by Professor Schreiber. His first article relates to the construction of the aneroids of Bourdon, Naudet, and Goldschmid, and the construction of an apparatus for testing aneroids without an air-pump. The examination of aneroids under the receiver of an air-pump has been attempted by Stewart and by Lovering; the comparison of an aneroid with a quicksilver barometer, by carrying both together to high altitudes, has been attempted, among others, by Holtschl. But all these attempts are unsatisfactory, and Schreiber has substituted therefor the following method: An iron receiver is made, in which the aneroid is placed, and which can be closed hermetically by a glass plate. The receiver is then connected with a manometer, so that air can flow in, and furnished with a stopcock, so that air can flow out. The changes of pressure of the air within the receiver are brought about by changing the temperature, which may be elevated to 50° Centigrade, or cooled to −20°, by which means pressures of from 730 to 570 millimeters can be attained. At the higher temperatures successive gradations of pressure are obtained by allowing the expanded air within to escape little by little through the proper cock. In a second paper, Schreiber considers the influences of changes of gravity upon the difference between the aneroid and the mercurial barometer, in which he combats the somewhat absurd theories of Herr von Wullerstorff-Urbair, who, besides a correction for gravity, suggests also a correction for terrestrial magnetism. The unimportance of the latter correction is proved by Schreiber, by simply causing the steel index-needle of the aneroid to be strongly magnetized, in which condition, however, no alteration took place in the reading of the instrument. The latest forms of construction of the aneroids suggested by Kohlrausch, Weilenmann, and Reitz are also elucidated by Professor Schreiber.

In a third communication, Schreiber explains a method of using the results published by Ruhlmann on barometric hypsometry, showing that in Saxony, at least, hypsometric measurements can be made without determining the temperature of the air at the time of observation, but by using the mean daily temperature.

In a fourth communication, Schreiber treats of the differences between the pressure of the air in buildings and in the open air, as brought about through the suction or pressure produced by the wind blowing into or past open windows. Similar effects have been observed and studied by James and Bache. Schreiber's observations were made in three places at the same altitude, two within houses and the third in the open air. In calm weather the pressure at all three places was the same. As soon, however, as the wind blew even with moderate force the pressure within the house was always lower than in the open air. It was also noticed that in the house the pressure oscillated with the strength of the wind, and every gust of wind was accompanied with a corresponding fall in the barometer; while in the open air the barometer remained quiet. The barometric depression within the house was quite considerable, amounting to one quarter of a millimeter for a velocity of six meters per second, and 1.15 millimeters for a velocity of 18 meters per second. —*5th Bericht Naturw. Gesellschaft, Chemnitz,* 1875, 17–22, 26–36.

A NEW FORM OF HYGROMETER.

Among the new forms of the hygrometer, are noted those as made by Lambrecht according to the plan and under the supervision of the inventor, Klinkerfues, of Göttingen. The method of construction of this instrument is not made public, but it is stated that it is always compared with the psychrometer, and that in every respect it is exceedingly trustworthy.—*Giebel's Zeitschrift ges. Naturw.*, 1875, XII., 300.

THE FORMATION OF SNOW AS OBSERVED FROM BALLOONS.

In a balloon ascension on the 29th of November, 1875, Tissandier observed that the fall of small crystals of snow which prevailed at the earth's surface ceased after reaching a moderate altitude. At 700 meters above the earth's surface the temperature was —2° Centigrade. At this altitude a thick cloud spread over the earth's surface, having a vertical depth of 800 meters. Within this cloud the temperature sank to —4° Centigrade. At 1500 feet above the upper surface of the cloud was found a stratum of ice crystals to the depth of 150 meters. Above this the temperature of the air was 0. The snow crystals had a very remarkable appearance; and the rise in temperature at this altitude depended undoubtedly upon the formation of the crystals and the evolution of latent heat.—19 *C*, 1876, 66.

RIVER CURRENTS AS AFFECTED BY THE EARTH'S ROTATION.

In Dr. Giebel's *Zeitschrift*, Dr. Dunker gives a somewhat elaborate essay on the influence of the rotation of the earth on the course of rivers, in which, after referring to his first memoir published in 1860, he refers to that of Von Bayer on the same subject, and states that his conclusion that rivers flowing either northward or southward in the northern hemisphere should have their right-hand banks steeper, higher, and more rapidly eaten away, applies also to the southern hemisphere, with the exception that there the left-hand banks are affected in that way. The further consideration of this subject leads him to the consideration of the movement of the winds on the earth's surface, and he gives a general formula, published first by Hollbaur, as applicable to the movement of any body on the surface of the earth, whether solid, gaseous, or liquid. Dr. Dunker seems to consider only bodies moving in the meridian either northward or southward, and treats at some length of the influence of the river in excavating and changing its channel.—*Giebel's Zeits. ges. Naturw.*, 1875, 463.

THE INTERNAL TEMPERATURE OF THE EARTH.

The origin of the interior heat of the earth is treated of in a few words by Professor Mohr, who states that if the interior is still molten, it follows that the nearer we approach this nucleus, not only must the temperature increase, but must do so in an increasing ratio; so that for a given increase of temperature we require to penetrate into the interior of the earth through a decreasing number of feet. Now the deepest artesian well as yet executed is at Sperenberg, about twenty miles south of Berlin. This well was begun in 1867, and has already reached a depth of over 4000 feet, at which depth Magnus measured the temperature (38.5° Reaumur) by means of his geothermometer. The observations of temperature that have been made in this well were executed with the greatest care; each position of the thermometer being cut off from connection with the upper or lower portions of the well by plugging up the tube. The most probable results of these measures are given in the following table:

Depth. Prussian Feet.	Temperature. Reaumur.	Depth. Prussian Feet.	Temperature. Reaumur.
700	15.654°	1700	25.623°
900	17.849°	1900	27.315°
1100	19.948°	2100	28.906°
1300	21.931°	3390	36.756°
1500	23.830°	4052	38.500°

There results from these measurements a very remarkable but well-established result—that the rate of increase of temperature is continuously growing less as we descend. This increase diminishes at the rate of one twentieth of a degree for every hundred feet, so that it is easy to compute at what depth the temperature will cease to increase. This depth is found to be the very moderate one of 5190 feet, at which a temperature of about forty degrees might be expected to prevail. Even if we do not attribute absolute accuracy to these observations, yet we see that a constant temperature must be attained at a depth far within twenty miles; and that the temperature itself even at that depth must be far less than the melting-point of the rocks. The result of these observations at Sperenberg is therefore completely in accordance with those deduced by Vogt from operations at the artesian well at Grenelle; and if we attribute any value at all to these calculations, they seem to give a death-blow to the Plutonic theories of former geologists.—*Verhandl. Naturhist. Vereins, Bonn*, XXXI., 267.

EARTH TEMPERATURE AT KÖNIGSBERG.

The results of a series of measurements of the temperature of the earth, as made at different depths in the botanical garden at Königsberg, has been communicated by Dr. Dorn to the Physical and Economical Society of that city, who remarks that while the series is of too short a duration to justify a very extended investigation, yet one thing is remarked, viz., that the annual mean temperatures as derived from the deeper thermometers are invariably lower than those derived from the surface thermometers instead of being higher, as is usually the case. This anomaly, however, is abundantly explained if we consider that the winters of the years 1869, 1870, and 1871 were of an exceptionally low temperature; and this wave of cold had, in 1873, only just reached the depths in the earth at which the lower thermometers were placed, while the upper thermometers during that year were exposed to an unusually mild temperature.—*Schriften Ostpreussische physikalisch.-ökonom. Gesells., Königsberg*, XV., 18.

THE INTERIOR STRUCTURE OF THE EARTH.

The mode of formation of the inequalities of the earth's surface forms the subject of a thorough study by Osmond Fisher, in a memoir published in the twelfth volume of the Cambridge Philosophical Transactions. He concludes that the molten earth first solidified from the centre, and, after a time, from the surface also; so that there is probably at present a thin layer of molten material between the solidified crust and the solidified interior; and that the solid crust therefore rests in corrugations upon a liquid or quasi-liquid layer. The conditions of equilibrium of such a crust are, first, that it must be considered flexible; second, it must be in unstable equilibrium; and, third, therefore oscillations of the surface are possible. Mr. Fisher makes an approximation to a rigorous mathematical investigation by inquiring what form would be assumed by a heavy, flexible crust resting upon a liquid in a rectangular trough shorter than the crust; and shows that when any extraneous force acts upon the crust, it will assume the form of a series of equal circular arcs. The same conclusion holds good when the trough is supposed to be very long, and opened lengthwise into a circular form corresponding to the surface of the earth.

The further conclusions of Mr. Fisher are expressed in the mathematical equations introduced by him. — *Cambridge Philosophical Transactions*, XII.

THE THERMAL SPRINGS OF THE UNITED STATES.

A very complete list of thermal springs in the United States, with the temperatures of their waters as far as they have been observed, is given by Mr. G. K. Gilbert, of the Survey of the Territories West of the Mississippi. He considers the thermal springs as being a valuable indication of the method by which inequalities of the earth's surface have been formed. Hot springs are generally found where the rocky structure is such as to admit of easy communication with subterranean waters. Tilting and fracture of strata are concomitant features of mountain corrugation; and in regions of such corrugation we should look for thermal waters. Designating upon a map the localities of the numerous springs reported by Mr. Gilbert, the first thing noted is that the Mississippi Valley contains no hot spring, nor do the plains of the Atlantic coast. Among the Ozark Mountains of Arkansas we have one. In the Colorado Plateau five localities are noticed. The distribution of hot springs is found to coincide very exactly with that of corrugation. The range of temperature of the waters is far higher in the western region than in the eastern.—*Hayden's Survey and Reports*, 1876, 145.

CONNECTION BETWEEN SOLAR SPOTS AND TERRESTRIAL ELECTRICITY.

As the result of his study upon the frequency of thunder and lightning storms in Germany and Switzerland, Von Bezold concludes it probable that high temperature as well as a solar surface free from spots are the conditions bringing about years rich in electrical displays. Since, however, the maxima of solar-spot surface agrees with those of greatest intensity of the auroras, it follows that both kinds of electrical phenomena, thunder-storms and auroras, are in a certain manner complementary to each other, so that years rich in thunder-storms are poor in auroras, and *vice versa.* Such a connection between sun-spots and thunder-storms implies, however, by no means the assumption of a direct electric interchange between the earth and the sun, but can rather be considered as a consequence of the variable solar insolation as dependent upon the solar-spot surface. The variations of insolation, according to Köppen, are not felt simultaneously, but rather successively in the various latitudes of the earth. The thunder-storms depend not only upon the temperature of the place of observation, but also upon the condition of the atmosphere at points far distant and belonging to other climatological zones, as is best seen in the thunder-storms accompanying extensive storms. In this way perhaps can best be explained the peculiar position which the curve of thunder-storm frequency holds between the solar-spot curve and the temperature curve.—*Sitzb. K.-B. Akad. der Wissens., Munich*, 1874, IV., 318.

THE FORCE OF SEA WAVES.

In connection with a memoir on the Manora Breakwater, read before the Institution of Civil Engineers, London, by W. H. Price, some remarks were made by Mr. David Stevenson and others on the effect of sea waves in breaking up heavy masses of masonry. A remarkable instance of the power of such waves was afforded in the case of the breakwater at Wick, on the coast of England. The height of the waves at this place was several times measured and estimated, the result being about forty-two feet from crest to hollow. Stones of eight and ten tons' weight were by such waves carried from the parapet to the top of the breakwater. It was resolved finally to construct the outward extremity of the breakwater by depositing three courses of one-hundred-ton blocks of stone on the rubble base, as a foundation for three courses of large flat stones, surmounted by a monolith of cemented rubble built on the spot. The end of the breakwater, therefore, was in substance a monolith weighing upward of eight hundred tons, being about 26 feet by 45, and 11 feet in thickness, cemented to the underlying rubble base. Incredible as it might seem, this huge monolithic mass succumbed to the force of the waves. It was actually seen by the resident engineer to be bodily slewed around by successive strokes, until it was finally removed and deposited inside of the pier. In fact, not only the upper portion, but the three lower courses of stone, forming a mass of 1350 tons, were removed without breaking.—*Minutes and Proceedings Institution of Civil Engineers, London*, 1876, 40.

CLIMATE OF THE CAUCASUS.

Dr. Radde, in some remarks on the geology of the Caucasus, shows that the physics of the surrounding land is rendered entirely different by the presence of these great mountain ranges. The limit of perpetual snow in the Caucasus sinks to ten thousand feet in the moist districts of Colchis, but rises on the northern side of the Caucasus, where the dry east and northeast winds prevail, and where there can be only a slight precipitation of snow, until on Mount Ararat, even at the height of 14,300 feet, vegetation is found. There is, therefore, a difference of at least 4000 feet in the limits of perpetual snow in different portions of the Caucasus. The culture of the vine succeeds without special protection in winter at an altitude of 3600 feet in Colchis, while on the east side of Mount Ararat, even at the height of 3000 feet, the vines must be protected in winter.

Over a hundred hot springs are known in the Caucasian range; and, according to Radde and Abisch, the distribution of these springs is independent of the extensive volcanic activity that exists in the former geological peaks. On the other hand, the springs as well as the volcanic phenomena are distributed in cognate methods along the dividing lines of axes of elevation and dislocation.

The most remarkable collection of mineral springs is at Pjatigorsk, where within the space of twenty-five square miles every possible kind of mineral springs is found: sulphur springs, alkali springs, iron springs, and muriatic-acid springs, all of which are abundantly visited by invalids.—*Sitzungsb. Ostpreuss. physikalisch-ökonom. Gesells., Königsberg*, p. 8.

THE EASTWARD PROGRESS OF STORMS.

Robert Tennant, Esq., has endeavored to elucidate his views on the causes by which storms progress in an easterly direction. According to him the barometer rarely indicates the pressure due to the weight of the air directly above it; but owing to the sluggish currents at the surface of the earth and the rapid currents above, the pressure is diminished at the surface of the earth, although it may remain undiminished at higher altitudes. When in consequence of high winds the barometer falls, a spiral inflow then takes place toward the centre. This inflow is unequal on the different sides, being for Great Britain less on the east and northeast side, and greatest on the southwest side, in consequence of which the centre of the barometric depression moves eastward. As regards the truth of his statement that the barometer can not give a true indication of weight when the atmosphere is in motion, there can be no doubt; but the exact amount of the diminution of pressure, as calculated by well-known formulæ, is probably much less than that assumed by Mr. Tennant.—*Proceedings Royal Society, Edinburgh*, VIII., 612.

HAIL-STORMS IN FRANCE.

Sales contributes a pretty full study upon certain hail-storms which visited France in June and July, 1874, of which that which occurred on the 28th of July was especially remarkable. Two occurred on the 26th of June, covering quite distinct sections of country, between which there seemed good reason to believe that some connection existed, although its exact nature is not indicated by the theory. Very curious are the isolated points observed by him at which hail fell apparently without any connection with other more extensive hail-storms occurring at a distance. The principal object of his inquiry has been the connection between hail-storms and altitude above the ocean. In general the hail begins in the valleys, and rarely is observed at stations more than one thousand feet above the sea; which limit seems to offer insuperable obstacles to its formation in France, although not in America, where the heaviest hail-storms occur at higher altitudes.—*Mém. Acad. des Sciences, Toulouse,* 1875, 285.

RED SNOW ON THE PIC-DU-MIDI.

The establishment by the United States of meteorological observatories on Mount Washington and Pike's Peak seems to have stimulated the action of other meteorological offices in the same direction. Thus, in France, the observatory on the summit of Pic-du-Midi has formed quite an epoch in meteorological study. A number of interesting results, drawn from the first year's observations, are presented to the Academy of Sciences of Toulouse by Dr. Armieux, who specially calls attention to the hypsometric results, and to the peculiarly interesting phenomena of red snow. After a short historical survey of our knowledge of the red snow, to which he himself had previously contributed somewhat in his article "Topography of the Sahara," published at Algiers in 1865, he shows that the presence of red snow on the Pyrenees has been established beyond doubt. It has therefore thus far been observed both here and also in the Alps, Spitzbergen, Greenland, and New Shetland, and in the antarctic zone, to which we may also add an occasional record of its appearance in North America. From the drawings and description of the red coloring particles as seen under the microscope of Dr. Armieux, it is evident that with the red particles are mixed occasionally green ones; and the cryptogamous nature of the substance is placed beyond a doubt.

The explorers in the Swedish North Pole expedition have seen marine algæ growing and fruiting at a temperature far below zero, while at higher temperatures the spores completely disappeared. There are therefore some vegetables which can only live in intense cold and continuous dryness; and to these the cryptogams of the red snow must be nearly allied. Many of the figures observed by Armieux bear close analogy, he states, to those figured by Cohn in his beautiful memoir published at Breslau in 1872; whence he concludes an intimate relation between the *Protococcus nivalis* and the *Protococcus pluvialis.—Mém. Acad. des Sciences de Toulouse*, 1875, 195.

THE WINDS AND RAINS OF INDIA.

A valuable memoir on the winds of Northern India, presented by Henry Blanford, of Calcutta, to the Royal Society of London, has recently come to hand, in which this subject is treated of in the fullest and most admirable manner. He first describes the general scheme of the wind system of Northern India, in which he shows that it is very different from that of the adjacent seas. Instead of two monsoons from northeast and southwest prevailing alternately during about equal periods of the year, we find a great diversity of prevalent wind currents depending upon the direction of the mountain ranges and of the great valley plains; and with respect to period to be classified under three rather than two distinct seasons, excepting, indeed, in Upper Assam, where the normal monsoons prevail. In the cold weather months, from November to January, the wind appears to flow in a gentle current from a distinct source in the hilly regions southward, down the valleys of the Indus and Ganges, or across the water-shed of Central India. In hot weather the winds draw around to the westward, and dry currents radiate out over the whole region, and, becoming heated, form the well-known hot winds of April and May. These winds, however, are essentially diurnal winds. In June the southwest monsoon sets in on both coasts of the peninsula.

The relation of the winds to temperature, humidity, and barometric pressure is most carefully presented in detail. In a general summary he states that the northeast monsoon of the Indian seas is produced by the cooling and condensation of a comparatively calm atmosphere over the land surface of India. Its origin is in the plains of the Punjab, and Upper and Central India and Assam, probably also on the southern slopes of the Himalaya. These wind currents are fed by an upper current which he terms the *anti-monsoon*, of which he traces two distinct branches.

The double system of upper and lower currents is presented by him in admirably constructed charts, on which both are shown in their proper relations to each other. The southwest monsoon is produced by the heating of the land surface of the peninsula. As the heat increases the pressure falls steadily, and the sea winds are drawn from a greater distance south. At length, in general, the ridge of high pressure over the sea, which has been steadily receding southward since February, is obliterated, and the southeast trade, or perhaps only a portion of it, crossing the equator, brings the monsoon rains to Bengal and the western coast of India.—*Phil. Trans. Royal Soc. of London*, CLXIV., 363.

ORIGIN OF CYCLONES.

The origin of the cyclones of the Bay of Bengal has been studied by Blanford, of Calcutta, who concludes that they are not necessarily produced by two parallel currents blowing in opposite directions, but rather that a calm state of atmosphere, or one in which the winds are light and variable over an open sea, is a condition favorable to the formation of these storms; and that a second condition is high or moderately high temperature. In consequence of this collocation, a large quantity of vapor is produced, ascends into the atmosphere and is condensed, with a liberation of its latent heat over the place of its production instead of being carried to some distant region. The atmospheric pressure is thus locally lowered, tending to cause an indraft of air. The formation of cyclones is, then, finally determined by an inrush of a saturated storm-current of air from the southwest or west-southwest. This latter feature may possibly be one peculiar to the northwest portion of the Bay of Bengal; and Blanford especially guards himself against being supposed to extend these views to the case of any other area than that which he has especially dealt with.—*Phil. Trans. Royal Soc. of London*, CLXIV., 563.

DRY THUNDER-STORMS.

A correspondent in Oregon, Missouri, states: "When the earth has become dry, parched, and very warm, I have often, on the occasion of thunder-storms, noticed for hours, while it was thundering very hard, a mist falling from the storm-clouds, and roll back, after nearly reaching the earth, in the form of lighter vapor. I think this rain or mist in falling passed down to the stratum of very hot air on the earth's surface, and became a steam; large volumes of white vapor, forming suddenly, and rolling back and up. Now I am confident that if the earth had been shaded by trees this rain or mist would have fallen on the ground. This phenomenon can be seen here every hot, dry season. My attention was called to it by a question asked while one of these dry thunder-storms was prevailing—the thunder rattling overhead, and not a drop of rain falling. The white mist is not easily observed overhead, where all is light, but opposite the sun under a dark storm-cloud it is very plain, and must attract attention."—*Appleton's Popular Science Monthly*, IX., 765.

TEMPERATURE OBSERVATIONS IN ITALY.

The distribution of temperature in Italy is the subject of an elaborate memoir by Ragona, as published in the supplement to the Italian Meteorology for 1876.

Starting with the annual movement of the sun, Ragona passes to the remarkable formulæ that have been published by Liaias, Schmidt, Waltershausen, and others, by means of which the distribution of temperature over the whole earth is represented in a very conspicuous manner. The still more remarkable work of Forbes on this subject seems to have been unknown to him. The detailed study of temperature at Modena from the observations of ten years afforded him an opportunity to make many interesting connections between temperature and other correlated phenomena, as, for instance, the appearance of the auroras of the 4th of February, 1872, and the 4th of February, 1874.—*Meteorol. Ital.*, *App.*, 1875.

RAINFALL, WINDS, AND PRESSURE IN ITALY.

The distribution of rain in Italy for the years 1871 and 1872 is the subject of an elaborate memoir by Denza, in which, after a careful discussion of actual observations of rainfall and evaporation over the whole of Italy, he considers the theoretical question of the cause of the peculiarities of the distribution of rain in Italy in general, and especially in 1872, and has elucidated the distribution of the winds in Italy. Denza adds to the memoir on rainfall one on the distribution of barometric pressure, as shown by the averages of 1870 to 1875.—*Meteorologia Italiana*, *Supplement*, 1875, 41.

THE BORA OF SOUTHERN RUSSIA.

Baron Wrangell has written a very interesting paper on the causes of the Bora, or northerly gales, at Noworossisk. This place, situated on the Black Sea, would, it is said, have the finest harbor in the East, were it not for its exposure to the strong north winds. According to Wrangell, this wind gains most of its force in that locality from the fact that it is a cold wind flowing down the mountain-sides; and as we can not prevent cold dry air from becoming colder by radiation under a clear sky, he proposes to diminish the violence of the wind by cutting a passage through a spur of the mountain in such a way as to relieve the mass of air behind from any confinement whatever, so that the moment a slight increase of density takes place that air will flow away quietly through the artificial valley. The approximate formula deduced by him for computing the velocity of the wind, when the temperature of the air and the barometric pressure are given, is derived from an ingenious course of reasoning, and gives a close approximation to the observed true velocity.—*Wild's Repertorium*, 1875.

FREQUENCY OF THUNDER-STORMS IN EUROPE.

An investigation into the frequency of thunder-storms during the summer months in Europe has been made by Von

Bezold, who is led to the conclusion that the phenomena of thunder-storms show, in general, during the summer months in the northern hemisphere, two maxima. These maxima approach each other in proportion as we go away from tropical regions. They are scarcely distinguishable in Germany, but are recognized by taking advantage of the observations in Barnaul and St. Petersburg. Of all the stations examined, only one, Katherineburg, shows a single maximum, and the climate of this station is certainly, on many accounts, to be considered as influenced less by the meteorological conditions of the tropical zones than almost any other point in Europe. It is considered therefore that we shall not go far wrong if in the two maxima of electric phenomena, which is so plainly seen in Europe, we recognize an echo of the two summers, or the two maxima of temperature experienced in the tropical zones. — *Sitzb. K.-B. Akad. der Wissens., Munich*, 1875, 220.

CONSTITUTION OF THE ATMOSPHERE OVER THE LIBYAN DESERT.

Pettenkofer has examined the air brought back from the Libyan Desert by Dr. Zittel, the companion of Dr. Rohlfs, with respect to the quantity of carbonic-acid gas contained therein. He finds that the atmosphere in the desert has precisely the same chemical constitution as in Germany, where the quantity of carbonic-acid gas varies between two and a half and five ten-thousandths. He has also examined the air contained in the water of springs, and finds the same agreement. — *Sitzb. K.-B. Akad. der Wissens., Munich*, 1874, IV., 339.

EFFECT OF TIDES ON THE ROTATION OF THE EARTH.

Mr. Tylor, in some remarks on a new theory of tides and waves, advocates the view that the level of the ocean is nearly represented by high-water mark on coasts and bays where there is free access of the tide, or in a channel without a constant flow. He states that he entirely disbelieves in tidal action having the smallest effect on the rotation of the earth, and that the assumption of a great heap of water traveling in one direction is a gross error. He also suggests that some geological difficulties, such as the evidence that tides during the quaternary periods were three or four times as large as at present, may be explained by periodic changes of position of part of the interior of the earth, rather than by supposing great changes in the distance of the moon from the earth.—7 *A*, XLVIII., 204.

THE DIMINUTION OF WATER IN SPRINGS, RIVERS, AND WELLS.

The report of Wex on the diminution of water in wells, etc., presented to the Austrian government in 1873, was followed by the appointment, at his request, of a commission of engineers, to whom was intrusted the duty of carefully investigating the points raised by the author in his learned memoir. So important did the matter seem, on account of the long-matured views presented by Wex, that the commission decided to fully investigate the matter. The rivers Danube, Rhine, and Elbe were respectively assigned to certain engineers, while others made measurements in relation to the Alpine streams and the glaciers, and others again undertook a special study of the meteorological questions involved.

During the past two years the committee has accumulated a great mass of valuable material, and has presented a very elaborate report on the subject, which was published in a recent number of the Journal of the Austrian Engineers and Architects' Association. The many details given in the report of the committee may perhaps be summed up as follows: First, an increase is proved in the frequency and the heights of floods in the rivers, as well as a diminution in the altitude of the mean of low waters in most of the rivers and streams of cultivated lands; and all the evil consequences depicted by Wex follow thereon; second, the cause of the injurious changes in the regimen of the rivers, in the drainage of swamps and morasses, in the sinking of lakes and dikes, is principally to be found in the destruction of the forests. These two points having been abundantly established by a large corps of able engineers, the conclusions and the recommendations of the Austrian committee become of the greatest interest to other nationalities, since it is evident that the same causes are at work elsewhere, and especially so in America, to bring about the same disastrous results. The committee recommend that on the one hand exact measures be made of all that relates to the hydrography of the land, implying, of course, the establishment of a permanent hydrographic commission; second, that the most stringent laws be enacted to prevent the willful unnecessary destruction of forests; and, third, that every thing be done that is possible to encourage the planting and cultivation of forests; and, finally, that the streams and rivers, as they at present exist, be connected into a system by means of which the height of the water may be regulated, and the traffic therein facilitated as much as possible.—*Zeitschrift des Ingen.- und Architekten-Vereins*, p. 137.

MAGNETIC PARTICLES IN ATMOSPHERIC DUST.

The atmospheric dust examined by Tissandier was collected in several different ways, and in every case was found to contain minute magnetic ferruginous particles. Part of the dust was collected upon sheets of paper exposed to the air for many days; in another series of experiments air was passed through pure water, and the latter evaporated over sulphuric acid in vacuo. Other samples were collected from rain and snow water, in one instance, particularly, from snow gathered upon Mont Blanc, 2712 meters above sea-level. The ferruginous particles occurring in these various specimens of dust were extracted by means of a magnet and subjected to microscopic examination. In diameter they rarely exceed $\frac{2}{100}$ of a millimeter, and appear to consist of magnetic oxide, resulting from the combustion of iron. Tissandier believes them to be of cosmical, not terrestrial origin, and regards them as the *débris* of meteoric masses.—6 *D*, 1875, *Oct.* 4.

ON THE HEIGHT OF THE AURORA BOREALIS.

In discussing observations made by himself upon the aurora during the Swedish expedition of 1868 to the North Pole, Professor Lemström, of Helsingfors, states that although Loomis, and even Bravais, believed that observations which give a very low height to the aurora are erroneous, and the result of some illusion, yet he can not agree with them; and he offers in support of his opinion, among other things, the phenomena observed on the 18th of October, 1868, at the entrance of the Norwegian Archipelago, when the whole horizon was covered with rays which were soon united around the magnetic pole, forming a regular crown.

All the phenomena that he has observed and described in regard to the illuminated edges of clouds show very plainly that in these cases the polar light was produced in the region of the clouds, and even lower. We know by numerous observations that the number of thunder and lightning storms diminishes considerably as we approach the polar regions, so that they no longer occur in the latitude of 70°. Must we then conclude that in these regions the clouds are completely deprived of electricity? Certainly not; but only that the electrical discharges are made in some other way. In these high latitudes, electricity is discharged not only by clouds, but also directly by damp air, as takes place in the winter in the temperate zones. A great many direct observations prove the existence of slow discharges of this nature; and a very remarkable confirmation is given by Angström, who on one occasion proved the presence in the spectrum of the yellow or auroral ray over almost the entire sky.—*Smithsonian Rep.*, 1874, 232.

RELATION OF THE PHASES OF THE MOON TO ATMOSPHERIC PRESSURE.

In a memoir by Ludicke, he shows that the atmospheric pressure diminishes with the waxing and increases with the waning moon. The pressure is less at the perigee than at the apogee, and in general the effect of the moon upon the atmosphere is the inverse of that which it produces upon the ocean. The observations on which his results are based extend over eight years; but the actual effect of the moon upon the barometric pressure, although decided, is yet exceedingly small.

IRON IN ATMOSPHERIC DUST.

As the result of an examination of atmospheric dust, the mineral residuum from the melting of snow, etc., with special reference to iron in the atmosphere, Mr. Young remarks that this metal, in appreciable quantity, occurs in the dust accumulated in old buildings during a long period of time, and is usually of a globular form, showing that it has been formed at a high temperature. The iron as found in melted snow is much more irregular in shape, and is more abundant in proportion when the snow is collected at the lower levels. Mr.

Young has not been able to establish the occurrence of iodine in snow-water, as claimed by other experimenters. — 6 *B*, 1876, *July* 17, 242.

SCHOTT'S TABLES OF ATMOSPHERIC TEMPERATURE.

An important work has recently been issued by the Smithsonian Institution, entitled "Tables of Atmospheric Temperature in the United States," by C. A. Schott. The special result reached by Mr. Schott, in reference to secular variations of temperature, are of such general interest and importance that we quote some of his conclusions: "The character of the secular variation in the mean annual temperature is that of a series of irregular waves representing a succession of warmer and colder periods. These undulations, when computed for a number of stations exposed to similar climatological conditions, are seen to have approached to parallelism over large tracts of country. There is, however, nothing to countenance the idea of any permanent change in climate having taken place, or being about to take place. During the last ninety years the thermometric records of mean temperatures show no indication whatever of a sudden rise or fall." A similar conclusion has also been reached by Mr. Schott in reference to the rainfall. "If, now, we group together stations properly located, the undulations become well marked, the interval between successive *maxima* or *minima* being about twenty-two years on the Atlantic coast and seven years in the Mississippi Valley. Even these undulations, however, are not sufficiently regular to serve as a basis of prediction. A comparison of the temperature with the frequency of the solar spots show, so far as these records go, no traces of any direct connection between these phenomena. On comparing the temperatures and the rainfalls, there seems some ground for concluding that years of high mean temperature have also a large rainfall. And, again, for years of low temperature the winds appear to be northerly, and for high temperature southerly. The connection between the temperature, the rain, and the winds must, however, be ultimately considered as due to variations in solar radiation."

C. GENERAL PHYSICS.

THE RELATION BETWEEN GRAVITATION AND ENERGY.

In a paper on the relation of the law of gravitation to the principle of the conservation of energy, Rev. George P. Young, of Toronto, proposes to show that if this principle be accepted, it must follow that the force of gravitation, which, at ordinary sensible distances, is one of attraction, must at a certain limit necessarily undergo a transformation into a force of repulsion. He concludes, moreover, that there is a higher law than that of conservation of energy, which law is expressed by him in certain mathematical formulæ, from which he deduces both the law of gravitation at ordinary limits, and the law of repulsion within certain limits.—*Canadian Journal of Science*, XIV., 589.

THOMSON'S DEAD-BEAT ARRANGEMENT FOR CHEMICAL BALANCES.

In giving an account of Sir William Thomson's arrangement for lessening the vibrations of delicate chemical balances, Professor Tait states that this method consists in suspending from the beam two very light closed cylinders, which fit closely, but without touching, into two fixed cylinders open at the top. This apparatus, when applied to a long and massive beam which ordinarily vibrated for some minutes when disturbed, brought it to rest in three half vibrations. There is therefore practically no limit to the length and consequently to the sensibility that may be given to the balance beam.

An instructive aero-dynamical phenomenon is noted by him in this connection, viz., the closed cylinder, when exactly balanced inside of the open cylinder, can be made to ascend briskly by a current of air, even when the latter blows vertically downward upon the centre of the upper end of the cylinder.—*Proceed. of the Roy. Soc. of Edinburgh*, VIII., 491.

SIMPLE DYNAMOMETER.

Dr. Hamilton, of the Long Island College Hospital, mentions that, having a necessity for a dynamometer for therapeutical purposes, he devised the following construction: A glass tube dips into a bulb of pure India rubber. The interior of the bulb is filled with colored water, which, by pressure upon the bulb, is forced up in the tube, the upper part of which is filled with air, which is thereby compressed. Attached to the tube is a scale whose divisions represent pounds. As fifteen pounds' pressure to the square inch is required to compress the given body of air to one half its volume, of course that amount of force brought to bear upon the bulb will press the column of water half-way up the scale. This apparatus, besides the advantage of simplicity, cheapness, and great accuracy, has the further convenience that the bulb receiving the pressure is of a convenient shape, and can be used by persons of large or small hands. Again, the bulb is adapted to receive pressure exerted by all the flexors of the hands, and, finally, the action of the muscles is the same at different times, the same group of muscles being always brought into play, so that correct comparative tests may be made from day to day.—*Psychological and Medico-Legal Journ., April*, 1875, 256.

ON THE ELASTICITY OF ROCK-SALT.

Some physical experiments have been made by Professor Groth, of Strasburg, upon the elasticity of rock-salt. They involved, first, the preparation of rods of crystalline salt, some three inches in length and one fiftieth of an inch in thickness; these were made perpendicular to the plane of the cube, and also to the dodecahedron. For the determination of the coefficient of elasticity the rod of salt was fastened to a much longer rod of brass, and then set in vibration in the usual way; sand strewed on the vibrating rods determined the position of the nodes, and these in connection with the thickness gave the elasticity of the salt relatively to the brass. By comparing two rods, made as described, the effect of the intervening brass rod was eliminated, and the coefficient of elasticity for the two determined. The ratio obtained was 1 to 1¼ (nearly), expressing the relation between the elasticity normal to the dodecahedral planes with that normal to the cubic planes. This result is important, as showing that the elasticity in an isometric mineral, like rock-salt, is not throughout uniform, but is dependent upon the direction.

"FLOW" OF METALS.

Professor Thurston, who, nearly simultaneously with Commander L. A. Beardslee, ascertained that an increased power of resisting stress was developed in iron and steel by their subjection to a strain which produced distortion beyond the elastic limit, and gave them a set, has lately presented a paper to the American Society of Civil Engineers, in which he has given the results of extended researches as applied to other metals. He concludes that the simple extension or straining of any member of any metallic structure is not a cause of weakness except where it produces an actual reduction of section resisting rupture, or where it brings the line of stress into a new direction, in which it acts either with a larger component of force in the former direction of stress, or, as in the case of a reflexure of the metal, it takes the material at disadvantage strategetically after a new disposition of its particles has taken place.

The conclusion seems also proper that the elevation of the elastic limit by strain can only occur in metals which are elastic, and are capable of being placed in a condition of reduced resisting power by internal stress, by artificial or external force.

Finally, the conclusion has been arrived at that structures are not weakened by stresses exceeding the elastic power of their members, whatever the material of which they are composed, and even when made of metals having no elasticity, and capable of yielding, like tin, by flow, unless such strains as are produced are productive of actual molecular disruption.—*Letter of R. H. Thurston.*

THE PLASTICITY OF ICE.

Professor Dr. Pfaff has communicated to the Physical Society at Erlangen some experiments upon the plasticity of ice, his experiments being made with the object of obtaining some exact numerical data as to the pressure necessary to change the form of a mass of ice, since it is essentially interesting in the theory of glacial movements to determine the minimum pressure at which the ice is plastic. He finds that even the lightest pressure is sufficient to make one particle of ice slide from another, if it only acts constantly and at a temperature near the melting-point; that, in fact, near the melting-point ice behaves like wax. The results obtained by him completely explain the fact that the movements of glaciers are more rapid in proportion as the temperature rises; and the theory of glacial movements seems to receive through his experiments a new support. — *Sitzb. Physikal. - Medecin. Gesells., Erlangen*, 1875, 72.

PLASTICO-DYNAMICS.

Within the last few years a new branch of mechanics has been developed by Saint-Venant, known as plastico-dynamics, which occupies itself with the movements in the interior of plastic solid bodies; researches on this subject were made by Tresca, and published in 1864 in a work on the flow of solid bodies, and in a work published nearly at the same time by Saint-Venant on the torsion of prisms of various shapes.

Subsequently, in 1870, Tresca published a work in which he endeavored to explain the phenomena under consideration by tracing out the movements of the molecules of the bodies in question as they moved more or less slowly under the influence of the pressures and resistances to which they were subjected. His principle of the conservation of volumes has been developed by Saint-Venant, who has shown, however, that it is not entirely adequate to explain the observed phenomena, or to give satisfactorily the actual values of the strain in the interior of solid bodies undergoing deformation in consequence of external pressures. Both Tresca and Saint-Venant agree that the fundamental principle of the new science amounts to this, that at every point in the interior of a plastic body which is being deformed the greatest tangential component of the pressure remains equal to a specific constant peculiar to each substance; and from this principle alone Saint-Venant has recently established certain differential equations of the plastic movements, an integration of which would go far toward a complete solution of the problem. Failing in an analytical solution, however, he suggests that experiments must be resorted to, and defines with some precision the nature of the desired observations.—6 *B*, LXXXI., 115.

AN EXPERIMENT IN INSTANTANEOUS CRYSTALLIZATION.

Péligot has recently described in *La Nature* the following interesting experiment: Dissolve one hundred and fifty parts, by weight, of hyposulphite of soda in fifteen parts of boiling water, and gently pour the same into a tall glass jar so as to half fill it, keeping the solution warm by placing the glass in hot water. Then dissolve one hundred parts, by weight, of the acetate of soda in fifteen parts of hot water, and carefully pour it into the same glass, inclining the latter so that the second solution may gently flow upon the first, and form an overlying layer without mingling with it. When cool there will be two supersaturated solutions. If now a crystal of hyposulphite of soda be attached to a thread and carefully passed into the glass, it will traverse the acetate solution without disturbing it, but on reaching the hyposulphite solution will cause the latter to crystallize instantaneously in large rhomboidal prisms with oblique terminal faces. When the lower solution is completely crystallized, a crystal of the acetate of soda similarly lowered into the upper solution will cause it to crystallize in oblique rhombic prisms. The appearance of the two different kinds of crystals, and the method of their formation by the selection of the disturbing crystal, forms an interesting philosophical experiment. Though not mentioned in our source of information, it would be well to observe the precaution of covering the surface of the upper solution with a thin layer of oil, to protect it against disturbance and the falling in of dust-particles, by which the crystallization will readily be set up, and the foregoing experiment anticipated quite unexpectedly.

FRICTIONAL RESISTANCE OF WATER TO MOTION OF VESSELS.

In the report to the Lords Commissioners of the Admiralty on the experiments for the determination of the frictional resistance of water to moving surfaces under various conditions, it is stated that a number of surfaces were experimented with, the experiments being conducted by drawing known areas of the given body through the fluid. The results may be expressed generally by a formula based upon the assumption that the resistance offered to the particles of fluid is purely dynamic, dependent upon the weights of the particles and the velocities imparted to them. Consequently, for lengths of surface above fifty feet, the increase of the friction per square foot of every additional length is so small that it will make no very great difference in our estimate of the total resistance of a surface three hundred feet long, such as the side of a ship, whether we assume such increase to continue at the same rate throughout the last two hundred and fifty feet of the surface, or to cease entirely after fifty feet.—*Proc. Brit. School of Adv. Sci.*, 1874.

THE MOVEMENTS OF WAVES AND VESSELS AT SEA.

The study of the motions of vessels is prosecuted in the French navy with considerable diligence by means of the apparatus invented by Madamet, and described in a note in the *Maritime and Colonial Review*, May, 1876. This apparatus consists essentially of a Foucault regulator causing two pencils to traverse a cylinder with perfect regularity; the whole apparatus being swung on gimbals in such a way that every movement of the vessel is registered, as regards direction, velocity, and time, on a sheet of paper. This apparatus has been used on board of a number of French frigates, such as *L' Océan*, *La Minerve*, and *La Galissonniere*, while lying in the port of Brest, in order to determine completely the movements of vessels oscillating in a calm sea. At present the apparatus is employed in connection with that devised by Risbee, in order to measure the resistance of a vessel to careening.—*Revue Maritime et Coloniale*, *May*, 1876, 481.

VIBRATION OF FLUID COLUMNS.

The fact that a column of air can be set into longitudinal vibration has suggested to Kundt the possibility of producing similar longitudinal vibrations in columns of water. To this end he sets the tube containing the water in vibration, and finds that the success of his experiment depends principally upon removing from the liquid all traces of gas, whether the latter be absorbed or are in the shape of minute bubbles. The gases absorbed by the liquid are partially driven out by the vibrations, and appear as disturbing bubbles. The so-called tone figures of Kundt can be shown in the vibrating columns of liquid as well as in those of air, and can be used to determine the velocity of sound in the liquid. It is found that the thickness of the glass tube has an influence on the velocity of sound, such that the thicker the tube the more rapid is the propagation of the sound wave.—19 *C*, VIII., 7.

ON THE THEORY OF THE FLOW OF WATER OR GAS.

The important work of Boussinesq, entitled "An Essay on the Theory of Currents of Water," which will be printed by the Academy of Sciences of Paris in the twenty-third volume of its foreign memoirs, has received some interesting additions from its author, among which is one that treats on the transpiration of gases, which interesting subject is known to us at present only through the observations of Grohan, Exner, and others, but whose results are explained by the mechanical theories of Boussinesq. Other additions are those that relate to the uniform regimen of flowing water, and especially, the third addition, that which serves to complete the theory of vertical waves, in which the author calculates the loss of dynamic energy that the waves experience as a consequence of the mutual friction of the layers of liquid as well as the friction against the containing walls. —6 *B*, LXXXI., 466.

HYDRAULIC INVESTIGATIONS IN INDIA.

A very extensive series of experiments by Captain Allen Cunningham on the flow of water in rivers and canals is published as an extra to the professional papers on Indian engineering. After noticing the results derived from Humphrey and Abbott's study of the Mississippi, D'Arcey and Bazeir's studies in France, and Redy's studies on the Paraguay, Uruguay, and La Plata, he states that the primary object in his own investigations has been to test the applicability of the results of the American and French experiments to large bodies of water in regular channels.

Among the conclusions to which his own observations have led him are the unsteadiness in the motion of a large body of water, even in a uniform channel of great length; the velocity at any point varying considerably from one instant to the next, although the average velocity is sensibly constant. The curve representing the surface velocity of a current of water is strikingly regular, and is symmetrical with reference to the mid-channel, while its form depends upon the figure of the cross-section. In a very wide channel it has a flat curve. In a rectangular section in masonry it is approximately a quartic ellipse. The surface velocity near the margin decreases very rapidly, and at the margin itself is perhaps at zero. In cases of straight margins of great length there is a constant surface motion from the margin toward the centre, most intense at the margin. The average central surface velocity varies on a calm day nearly as the square root of the central depth. The curve representing the mid-channel vertical velocity is approximately a common parabola, whose axis is usually below the surface at a depth depending upon the state of the wind; but the form of the curve is hardly well enough determined to admit of inferring the bottom velocity. The line of maximum velocity is highest at mid-channel, and deeper as we proceed toward the margins.—*Professional Papers on Indian Engineering, October*, 1875.

GAUSS' THEORY OF CAPILLARITY.

Plateau states that, as is well known, Gauss has deduced formulæ relative to particular phenomena of capillarity, by starting from the principle of virtual velocities. The French scientist Moutier has recently shown that the theory of Gauss properly treated explains certain effects attributed of late years to the tension of liquid surfaces, without any necessity of especially assuming the existence of such tension. He has deduced also a general formula concerning the equilibrium of two liquids in contact with each other and with a solid. This formula contains certain constants relative to the different molecular attractions that obtain in the system; and now Van der Mensbrugghe, of Ghent, demonstrates that these constants themselves have a definite physical signification; that they represent, viz., respectively the tension at the free surface of the two liquids, the tension at their common surface, and the tensions at the surfaces of contact between the liquids and the solids.—*Bulletin Acad. Royale des Sciences de Belgique*, 1875, 366.

LIPPMANN'S EXPERIMENTS ON CAPILLARY ATTRACTION AND HIS ELECTRO-CAPILLARY MOTOR.

The facts in relation to capillary attraction, described by Mr. Lippmann, and of which he has availed himself in the contrivance of what he calls the electro-capillary motor, now exciting so much attention in Europe, are not original with him, but are due to Dr. Draper, who discovered them more than forty years ago, and made them the subject of a memoir inserted in *The Journal of the Franklin Institute* of Philadelphia, January, 1836, and again in *The London and Edinburgh Philosophical Magazine*, March, 1845, in a paper entitled "Is Capillary Attraction an Electrical Phenomenon?" In these memoirs Mr. Lippmann's facts are set forth, and the explanation of them is given. Dr. Draper formerly wrote a good deal on capillary attraction, regarding it simply as an electric phenomenon. His views on the subject are given in detail in the scientific journals above named, and also in *The American Journal of Medical Sciences.*

ON THE ELASTICITY OF GASES.

One of the most extensive experimental researches of modern times is that now being prosecuted by Mendelejeff on the elasticity of gases, the expenses of which are being defrayed by the Imperial Russian Society of Technology, the first of which is now published in the Russian language. Experiments made by Oersted, Rumford, Natterer, and Cailletet lead one to think that under considerable pressures all gases are compressed less than they should be as indicated by Mariotte's law. The greater part of the first volume of Mendelejeff's work is of course occupied with preliminary researches necessary to establish the accuracy of his instruments and methods. The volume concludes with a description of the first experiments made by him upon rarefied gases and upon air compressed under from one to three atmospheres. The results that he has obtained in operating upon air, hydrogen, and carbonic acid, under gradually decreasing pressures, lead to the conclusion that the product of the pressure into the volume diminishes with the pressure; the diminution being especially sensible for air, when the pressure becomes very feeble.—6 *B*, LXXXI., 501.

THE ELASTICITY OF PURIFIED AIR.

Some researches of Mendelejeff and Kirpitschoff show that the product of any volume of air by its pressure, which according to the law of Mariotte should be constant for all pressures, is not so for the air, varying considerably when the pressures diminish to so small a quantity as half a millimeter. This product in fact, which for perfect gases is constant, varied rapidly in the case of air. The deviations from the law of Mariotte for rarefied air are contrary to those observed by Regnault for compressed air. In fact, the product increases when the pressure increases, and diminishes when the pressure diminishes. These discordances are far larger than the possible errors of observation.

AIR PUSHED IN FRONT OF A PROJECTILE.

In investigating the various phenomena attending the impact of projectiles, Busch has studied the question as to whether a sphere falling into a fluid drives air before it, or whether the air is simply inclosed by the water as it comes together behind the sphere. The simple apparatus employed by him to study the question consists of a cylindrical vessel full of water in which a plate is hung having in the centre an opening so large that the sphere falling through the water will be caught by it. His experiments show that in the case of bodies falling with a very small living force, the air above the water has time to be completely pushed aside by the falling projectile. But that if the living force of the body is increased slightly to a certain limit, it no longer becomes possible for the air to be entirely pushed aside; but that a certain amount is pushed by the sphere forward, and the quantity of air so driven on increases with the increase in the living force to precisely the degree required by the measurement of Magnus, upon the quantity of air carried with the projectile into the water. If we increase the resistance of the fluid by taking some more viscid fluid than water, such as glycerine or oil, it is found that a greater living force is required in order to carry the air in front of the projectile into the fluid. Even in the case of a shot penetrating a solid body, such as a thin sheet of India rubber stretched over the opening in the plate, a certain quantity of air is driven through in front of the ball.—*Verhandl. Naturhist. Vereins, Bonn,* XXXI., 251.

ON THE PROPULSION OF AIR BY A JET OF AIR OR VAPOR.

An interesting and practically valuable series of experiments has been made by Romilly on certain phenomena, which may be described as the dragging or propulsion of the atmosphere along with a jet of air or vapor. Any such jet, blown from a fine spout, carries with it a certain quantity of the surrounding air. From an extensive series of accurate measurements made by him, he concludes in general that when the jet is received through a tube into a chamber pierced opposite to the receiving spout by an orifice equal and similar to it, the pressure within the chamber is reduced to one half. Second, that whatever distance the orifice of the spout may be, the effect is always greater if the direction of the jet is the same as that of the axis. In all directions inclined to the axis the effect diminishes very rapidly. The experiments made by him have included the use of conical and cylindrical tubes, and open and closed reservoirs.—6 *B*, LXXX., 189.

EXTENDING THE COMPASS AND INCREASING THE TONE OF STRINGED INSTRUMENTS.

At a recent meeting of the Musical Association of London, Dr. Stone stated that there are three ways in which a string may be made to give very slow vibrations, viz., by increasing its length, its thickness, or its density. He had adopted the third plan by covering a catgut string with heavy copper wire, which proved to be fairly successful. This had been improved upon by re-enforcing the vibrations by means of longitudinal struts or bars, applied to the double bass violin. Four strips of white-wood, curved to an elliptical figure, are passed parallel from end to end, on the inside of the belly of the violin. The result is the removal of what is termed by the musicians "wolf," or inequality and falseness of tone, with a great increase of power throughout the range of the instrument. The same process is equally applicable to small violins, and the bars can be removed at pleasure without damaging the instrument. As an illustration of what may be effected by this system, an instrument whose original cost was 1*s.* 9*d.* was exhibited to which this improvement had been applied, and its performances called forth great applause.—18 *A*, XX., 270.

CONDUCTION OF HEAT BY BUILDING MATERIALS.

The coefficient of conduction for heat of various building materials has lately been carefully investigated by Lang, who, in his studies, has endeavored to exclude the influence of radiation, and has made measurements by means of the thermo-electric multiplier. He finds that the stones considered by him are much better conductors of heat when wet than when dry, and that various classes of stones, such as marble, sandstone, granite, etc., have approximately the same co-efficients of conduction, while bricks of all kinds are much worse conductors than the natural stones.

CHANGE OF TEXTURE IN SANDSTONE BY HEAT.

According to Mr. John Young, the sandstone bottoms of iron furnaces assume, from the long-continued action of heat, a distinctly columnar form, the old lines of stratification being obliterated, thus showing that heat, as well as electricity and mechanical force, was an agent in the production of the columnar form of rocks.—15 *A*, *November* 20, 676.

ANTIQUITY OF THE BURNING MIRROR.

Buchwalder states, in reference to the burning mirror recently invented by Mouchot, that it was used as long ago as in the days of Numa Pompilius, in whose reign the priests in the temple of Vesta, according to Plutarch, employed a conical reflector, with a solid angle of ninety degrees, as a mirror for concentrating the rays of the sun, thereby producing the heat necessary to light the sacred fires.

OBSERVATIONS UPON RADIOMETERS.

Mr. H. A. Carrington communicates to the *Popular Science Review* a slight contribution in the way of experiments with radiometers, in which he has arrived at the following conclusions: First. That when the radiometer is receiving light or heat, being at a lower temperature than its surroundings, repulsion of the black disks must ensue, and continue until the temperatures are equalized. Second. When the radiometer is radiating heat, being at a higher temperature than its surroundings, attraction of the black disks, or the apparent repulsion of the white disks, must ensue, and continue until the temperatures are again equalized. Third. No source of light can produce repulsion of the black disks unless it is capable of raising the temperature of the residual air within the globe.—*Popular Science Review*, *April*, 1876, 137.

OBSERVATIONS ON THE THEORY OF CROOKES' RADIOMETER.

Professors Dewar and Tait, in the prosecution of their researches into the movements of Crookes' radiometer, have devised methods of producing very perfect exhaustion of air from a receiver; the most perfect vacuum being obtained by taking advantage of the absorbent power of charcoal. The movement of the radiometer, whose disks are of rock-salt, are traced to the unequal heating of the movable parts of the apparatus; and the explanation of the phenomena observed by them is deduced from the kinetic theory of gaseous pressure.—*Proceedings Royal Society of Edinburgh*, VIII., 628.

THE MECHANICAL PRODUCTION OF COLD.

Mr. A. C. Kirk has offered a memoir on the mechanical production of cold to the Royal Institution of Civil Engineers, which attracted extended discussion, and will probably lead to material improvements in many of the mechanical arts. He states that his attention was first drawn to the subject by noticing the inconvenience experienced at certain paraffin-oil works, where it was customary to extract the solid paraffin in winter by exposing the material to a low temperature sufficient to cause the paraffin to crystallize. At those works chemical methods of producing low temperatures had been introduced in order to avoid the otherwise expensive loss of time. These methods were too objectionable to be continued long, and the author was requested, as engineer to the works, to examine the methods invented by Dr. Gorrie, who had constructed a machine that was said to have produced ice in Florida. Mr. Kirk's early experiments with machines similar to those of Dr. Gorrie having been unsatisfactory, attention was turned to an air-engine, the reversal of whose processes it was thought ought to make a good cooling-machine; and, in fact, after many modifications and reconstructions, a degree of cold was produced by it sufficient to freeze mercury. This machine may be in the main described as follows: A steam-engine moves a piston backward and forward, by which the confined air is in a state of alternate compression and expansion. While the air is compressed in one space, the heat generated thereby is removed by a stream of water flowing through properly arranged pipes; and while the air is expanding and cooling in the other space, heat is abstracted from whatever has been placed in a second properly arranged receptacle. The only limit to the temperature attainable is the conducting power of the material of which the apparatus is composed. The air contained in the pistons may be at any pressure that the apparatus can withstand. The machines built for cooling large masses of water for the use of breweries, etc., are usually worked at from 100 to 120 pounds per square inch, the efficiency and capacity of the machine increasing with increased pressure. To keep up this pressure and meet leakage, a small compressing pump draws air through two boxes containing chloride of calcium. This is necessary to dry the air, for if the air be damp the moisture is deposited as snow in certain parts of the apparatus, and causes mischievous obstructions.

A NEW ICE CALORIMETER.

The ice calorimeter in all its forms measures quantities of heat by determining how much ice that heat can melt. In Bunsen's apparatus advantage is taken of the change of volume which ice undergoes upon fusion. This change occurs at one end of a column of mercury sustained in a capillary tube: as the ice melts the mercury descends, and the amount of fall represents the quantity of heat. But the use of a capillary tube in this apparatus affects the delicacy of all measurements made with it. So Schüller and V. Wartha propose a modification of Bunsen's calorimeter, in which graduated scales are done away with, the amount of mercury involved in any measurement made with the instrument being determined by direct weight. As the ice in the apparatus melts and the column of mercury falls additional mercury flows in through a peculiar suction tube, and the weight thus absorbed affords a measure of the heat. The details of the new calorimeter are not very complicated, but need the author's diagram for their explanation. The inventors tried to apply their instrument to determining the specific heat of some metallic titanium, and obtained a value apparently too high. Seeking the cause of their error, they found that the supposed metal contained nitrogen, being really a compound of the formula TiN_2.—35 *C*, *September*, 1875.

EXPERIMENTS UPON NON-LUMINOUS FLAMES.

The experiments by Knapp, and the subsequent ones of Blochmann, in which a luminous gas flame was rendered non-luminous by the introduction of gases indifferent to combustion, in place of air, have been modified by Wibel in such a way as to permit the heating of the mixed gases at the moment of combustion. The diluting gas was introduced through a glass tube, soldered into one of the draught-holes of the ordinary Bunsen burner, the others being closed, and the mixed gases were burned from a platinum tube, readily formed by rolling a piece of thin platinum foil spirally, slipped into the top of the burner. Two opposite horizontal Bunsen burners were arranged for heating this tube. Upon heating it when the flame was rendered non-luminous by air, as in the ordinary Bunsen burner, or by carbonic acid, nitrogen, or hydrogen, Wibel noticed the immediate formation of a luminous cone in the interior of the flame, which gradually disappeared when the heating burners were removed. The temperature required was not very high, especially if the gases were mixed in the proper proportions. The flame did not strike down, and in all respects resembled an ordinary luminous flame, affording soot, and also a continuous spectrum. Very slight decomposition took place in the hot tube with nitrogen and carbonic acid, as ascertained by analysis of gas taken from the flame by aspiration, as well as from the exceedingly slight deposit of carbon in the tube. A sheet-iron plate, perforated so as to fit the burner, prevented the products of combustion from the heating burners from coating the flame. It was also found that when the flames of two good Bunsen burners were brought in contact with the exterior mantle of flame, rendered non-luminous by carbonic acid, an interior luminous cone was formed, which disappeared immediately on their removal. He concludes from his experiments that the non-luminous character of the flame in Knapp's experiment is not due to dilution of the burning gas, according to the views of Frankland and of Blochmann, but rather to a cooling of the interior of the flame by the gas introduced—a view that is supported by the peculiarities of the flame when oxygen is the diluting gas. The luminosity of the flame of a substance containing carbon, other things being equal, depends upon the existence of a temperature in the interior which renders possible the processes of chemical decomposition and combination, from which the luminous body proper results. In ordinary cases the more or less cold gases formed from the illuminating material rushing up from beneath are heated sufficiently by the temperature developed in the exterior zone of combustion to produce the change necessary to luminosity.—35 *C*, IV., 1875, 220.

INFLUENCE OF PRESSURE ON COMBUSTION.

Some interesting observations have been made by Cailletet in burning different substances under pressure. He finds that pressure slightly augments the temperature at which combustion occurs, and that the luminous and actinic rays emitted by the burning body are considerably intensified. When a candle is made the subject of experiment, the base of the flame, ordinarily bluish and transparent, becomes white and very luminous. Soon, however, clouds of smoke are formed, due to incomplete combustion. Under similar circumstances the flame of phosphorus is not sensibly augmented in brilliancy, but sulphur, potassium, alcohol, and carbon disulphide burn much more vividly than in free air. —*Annales de Chimie et de Physique*, *November*, 1875.

THE ABSORPTION OF SOLAR HEAT BY THE ATMOSPHERE.

The discussions of the observations of the black-bulb-in-vacuum thermometer, made in England during the past five years, have led Mr. Stowe to the following conclusions in reference to the influence on solar radiation of the aqueous vapor in the atmosphere. First, when the tension of vapor is small, the radiation is greater than the average. Second, the north and northwest winds, which contain little vapor, show a greater intensity of solar radiation than the south and southeast winds. Third, the hourly changes, due to the varying altitude of the sun above the horizon, are well marked, and allow the approximate determination of the solar radiation as unaffected by the absorption in the atmosphere; this latter varying from a minimum of ten per cent. to a maximum of twenty per cent. A change in the elevation of the station, from 470 up to 1800 feet, diminishes the absorption by five per cent.—7 *C*, II., 57.

THE MATHEMATICAL THEORY OF LIGHT.

An exhaustive memoir on the interference of light, by Professor Lommel, is contained in the Proceedings of the Physical Society of Erlangen, in which he brings the phenomena of thick and thin plates of glass and of curved surfaces into one point of view. Some of the diagrams given by him remind one strongly of those multiplex curves treated of by Professor Newton in the Connecticut Academy of Sciences for 1874.—*Sitzb. Physikal.-Med. Gesells., Erlangen*, 1875, 106.

MATHEMATICAL THEORY OF LIGHT.

The connection between the elliptic polarization of light reflected from mirrors, and the refraction and dispersion of light when passing through transparent media, is developed in a very elaborate manner by Ketteler, who deduces a complete theory from the consideration of the expression $A+B\sqrt{-1}$, which expression Fresnel met with in his investigation of the subject of total reflection. The occurrence of this expression, to which the term "complexe" is given by the French and German mathematicians, is shown by Ketteler to result from the fact that the wave of light reflected from any surface may be considered as a complex wave, consisting of a superposition of two partial waves differing from each other by one quarter of a wave-length. The interpretation which Fresnel himself seems to have given is submitted to a rigid demonstration. Ketteler states that we are led more and more to the conviction that in all dioptrical phenomena we have to do not so much with a special constitution of the optical ether as with the synchronous vibration of the atoms of ether, and those of material bodies; and that, in fact, the ether itself may have the same inertia and density within as without the transparent body. His memoir is especially devoted to the development of the idea that there is a vibration of the ponderable atoms corresponding to the vibrations of the ether.—*Verhandl. Naturhist. Vereins, Bonn*, XXXII., 1 to 224.

DEEP-SEA SOUNDING BY PHOTOGRAPHY.

Dr. Neumayer has presented to the Geographical Society of Berlin a remarkable photographic apparatus for determining the temperature and the direction-current at any particular depth in the ocean. It consists of a brass box, hermetically closed, and having attached to it an apparatus resembling a vane or rudder. Within this box a thermometer and a magnetic needle are contained, behind each of which is placed sensitive photographic paper, and in front of each of which is a small nitrogen vacuum tube. The box contains also a small induction coil. When the apparatus is lowered to the required depth, the rudder causes it to take a direction parallel to the current there existing, and hence a definite direction with reference to the needle within. The thermometer soon acquires the temperature of the water outside, and becomes stationary. At this instant an electric current is sent to the box, which, by means of the induction coil inside, lights up the little nitrogen tube, the violet light of which, photographically very intense, prints, in about three minutes, the position of the needle and the height of the mercury column upon the prepared paper. The current is then intermitted, the apparatus raised, the photographic tracing fixed, examined, and placed upon record.—3 *B*, *Sept.* 3, 1874, 6.

DISPERSION OF LIGHT BY PRISMS.

Dr. Eugene Block attempts, in his Inaugural Dissertation, to make some additions to the theory of the refraction of light passing through systems of prisms. He says with apparent correctness in his preface that the many occasions on which the spectral analysis is applied in every branch of science has in the last few years brought about important changes in the construction of the apparatus. The greater part of these changes have been prompted, not by theoretical investigations, but by experimental methods, whereby it has happened that many errors have been suffered to remain in the construction of the apparatus which may have a material and deleterious influence upon the sharpness of the spectrum. Dr. Block has therefore made careful investigation and comparison of such instruments as are now in use, and has developed the theory of the refraction of light in systems of prisms. He has extended his investigations to converging and diverging bundles of rays, as also to the influence which imperfect prisms, or the inclinations of the prisms can have upon the purity of the spectrum. Among the theses defended by him at the close of his inaugural dissertation, we note that the Ketteler formula for dispersion is maintained by him as the most correct that is known; as also that the appearance of the aurora is dependent upon local climatic conditions.—*Block's Inaugural Dissertation*, 1873.

SPECTRUM DISPERSION OF GASES.

Lorenz communicates to the Royal Academy of Copenhagen an experimental and theoretical investigation into the chromatic dispersion of gases. His observations have been made by means of a small spectroscope, and were in part directed toward the constituents of the atmosphere, for which he gives the coefficients of refraction for each of the eight principal lines of the spectrum, and the necessary changes due to the moisture and temperature of the atmosphere. Pure oxygen, nitrogen, hydrogen, the vapor of water, alcohol, ether, chloroform, iodaethyl, carbon-sulphide, and ammonia are successively investigated by him in different degrees of density and temperature.—*Mem. Kongel. Danske Vidensk. Selsk., Copenhagen*, X., 486.

IMPROVEMENT IN SPECTROSCOPES.

Mr. Madan gives a simple method by which we may correct the curvature of the spectrum lines, a defect inherent in all spectroscopes as at present made. This curvature is due to the fact that the rays from different parts of the spectrum fall on the prism under different vertical angles. Mr. Grubb has lately proposed to correct the curvature by a method which had been already employed by Mr. Madan for more than a year past, and which consists in making the slit itself curved instead of straight, the curvature being so arranged as to neutralize the distorting effect of the prism. Mr. Madan's experience shows that the curved slits give perfectly satisfactory results, and that they may be easily adapted to any spectroscope; so that by having several such slits in succession, we may secure straight lines in the field of view for varying powers of dispersion. He finds that slits whose edges are curved to a radius of 21 centimeters, sensibly correct the distortion of a single carbon bisulphide prism, the reflecting angle of which is 60 degrees. A slit whose radius is 10 centimeters corrects the distortion of a train of two such prisms.

SPECTRUM APPARATUS FOR THE NEW OBSERVATORY AT POTSDAM.

The maker of the optical apparatus for the Bothkamp Observatory has lately finished the spectrum apparatus for the new observatory at Potsdam, which probably is the most complete instrument of its kind. The maker, H. Schroeder, says of it that the apparatus consists of 21 single prisms combined into a system according to Rutherford's method, they being moved automatically and in such a way that the motion is accomplished with mathematical accuracy and with the greatest ease. This automatic movement allows of exact differential measurements with hitherto unattained accuracy, and is the first apparatus of this kind that has been constructed as an exact instrument for measuring. According to Dr. Vogel, the measurements are perfectly trustworthy to the one-hundredth part of the interval between the double line D of sodium, the optical performance of this spectroscope being such that the sodium line is separated into nine fine lines. Almost all the principal lines of the spectrum are resolved into groups of lines, while new lines are seen among those hitherto known.—7 *C*, XI., 55.

THE ATMOSPHERIC LINES OF THE SOLAR SPECTRUM.

J. B. N. Hennessey, of the Trigonometrical Survey of India, communicates to the Royal Society of London a short memoir on the atmospheric lines of the solar spectrum as observed by him on the point known as Vincent's Hill, among the Himalaya Mountains, in the northwest province of India, at an altitude above the sea of 1700 feet. His observations were made not only with an old spectroscope, as used in 1868 to 1871, but with a newer and finer instrument supplied by the Royal Society in 1872; and he publishes a map of the solar spectrum, showing the atmospheric lines as observed with the latter instrument. A comparison of the solar spectrum, as seen when the sun was within two hours of the meridian and as seen at sunset, shows the very striking changes introduced by atmospheric absorption. Thus near the Fraunhofer lines A and B intense black lines are introduced, while others having but slightly less intensity occur near 48, 71, 81, 99, 101, and 183. Especially remarkable is the great increase of bands in the more refrangible portion of the spectrum; thus from 26 to 40, faint bands, and from 46 to 60, from 68 to 74, from 95 to 102, and 107 to 116, very decided bands appear at sunset, which are not visible at midday. Mr. Hennessey has observed sunsets to the number of about 100 since 1870, and has also noticed that during the autumn a kind of haze springs up in the horizon, growing higher and higher from day to day, and denser, forming a permanent winter bank of haze; by carefully observing the effect of this bank of haze on the solar spectrum, he has found beyond all question that as this bank rises day by day higher and higher, the corresponding sunset spectrum bands successively disappear, showing that the lines which are visible when the sun sets in the true horizon are introduced into the spectrum by reason of the greater thickness of the stratum of air traversed by the sunlight. He states that certain lines, for instance, number 813, are almost as good as a clock. This line commences to change as early as two or three o'clock P.M., and becomes an intense black stripe at the horizon. He states his conviction, also, that besides other changes in the solar light as the sun approaches the horizon, there is this peculiarity—that the rays of less refrangibility actually become visible, so that the spectrum appears to be extended toward the right hand.—*Phil. Trans. Royal Soc. of London*, 1875, 157.

OPTICAL NOTES BY MR. LEA.

M. Carey Lea, of Philadelphia, states that having a year ago published a train of investigations into the sensitiveness of certain substances to particular rays of light, leading to results incompatible with the late announcement by Dr. Vogel in reference to the sensitiveness of silver bromide when washed with color varnish, he has since then continued his investigations, and while on the one hand Dr. Vogel has adopted his own views, he himself on the other hand has been led to the positive conclusion that there exists no relation whatever between the color of the substances and the color of the ray to whose influence they modify the sensitiveness of the silver bromide.

METHOD OF ESTIMATING COLOR IN WATER.

Mr. King, city analyst of Edinburgh, has published in the *Chemical News* a method of estimating color in water for the purpose of determining the comparative turbidity of different samples. This method consists in adding to a known quantity of pure distilled water contained in a glass tube an aqueous solution of caramel of a certain strength until the tint communicated to the distilled water is found to equal that of the water under examination. The tubes he employs are made of perfectly colorless glass, fifteen inches long, and of such a diameter that when filled to within three inches of the top they will contain exactly eight ounces of water. The depth of color which the distilled water and caramel should exhibit is ascertained by adding ten grains, by volume, of solution of ammonium chloride to eight ounces of pure water, perfectly free from ammonia, in a glass tube, forming a column twelve inches long. The ammonium chloride solution should contain 3.17 grains of the salt in 10,000 grains of water. To this mixture, after proper agitation, 25 grains, by volume, of Nessler's solution are to be added; and this, after mixing, is allowed to repose for ten minutes at a temperature of 60° Fahr., when the color will form 30° of Mr. King's scale; or, in other words, 300 grains, by volume, or 30° (a degree being equal to ten grains by volume) of caramel solution, if of proper strength, will produce exactly the same depth of color when added to the same amount of distilled water (eight ounces) in a column twelve inches long. The caramel solution being thus prepared, in order to estimate the color two tubes of the dimensions stated are to be filled to within about three inches of the top, one with distilled water and the other with water to be tested. The caramel solution is then to be added to the distilled water until that is found to equal in color the water contained in the other tube. Every 10° consumed will represent 1° of color. The intensity of the color is ascertained by looking down through the length of the column.—1 *A, March* 25, 1875, 133.

FLUORESCENCE OF SOLUTIONS IN CASTOR-OIL.

Some coloring matter derived from woods that do not show any fluorescence when dissolved in water, alcohol, or other solvents, are stated by Charles Horner to exhibit this phenomenon when dissolved in castor-oil; and other substances which he dissolved in alcohol show this property with augmented intensity when treated with castor-oil. To obtain clear solutions, the materials are first boiled, then filtered, evaporated to dryness, and again dissolved in oil under the influence of heat. The fluorescence disappears when hot, but returns on cooling. A number of facts are given by him showing the increased intensity of the fluorescence of these solutions, and suggesting the importance of taking advantage of this property in studying the phenomena; in fact, it seems that fluorescence is a property of solutions rather than of simple substances.—7 *A*, XLVIII., 165.

THEORIES OF MAGNETISM AND LIGHT.

Boltzmann has experimentally confirmed the theory that light and electricity are only different forms of motion of one and the same medium, by showing that from it there should result a certain relation between the refractive power of a substance and its dielectric properties, a relation confirmed by observation. A further confirmation of the same theory has also been lately published by Boltzmann, based on investigations into the behavior of non-conducting bodies under the influence of electric forces. He says that, according to Maxwell's theory, the constant of dielectricity for non-isotropic crystallized bodies must depend upon the direction in which the electric forces act upon it, varying in a manner such as can be predicated from the optical properties of the body. The only double refracting crystals that are appropriate to the investigation are those of sulphur. Two spheres cut from crystals of sulphur, whose optical axes had been previously determined, were experimented with by allowing the electricity to act in various directions in reference to the optical axes. In this manner the magnetic axes, as they may be called, were determined, and were shown to agree with the optical axes; and the same results being arrived at from both spheres, he concludes that these observations not only confirm Maxwell's theory as to the nature of electricity, but also definitively decide that the vibrations of ether forming light are perpendicular to the plane of polarization.—19 *C*, VIII., 105.

THE INFLUENCE OF ARMATURES UPON MAGNETS.

Jamin, by very careful observation, has shown that the placing of an armature on the end of a magnet brings about a new distribution of the magnetic forces, but that the total force is neither increased nor diminished; the magnet itself loses, but the armature gains magnetic force.—19 *C*, VIII., 104.

FORMATION OF NATURAL MAGNETS.

Dr. Schönfeldt, of Dorpat, Russia, gives, in the Bulletin of the Naturalists' Society of Moscow, an exhaustive treatise, historical and otherwise, on the magnetic forces discoverable in various kinds of matter. After giving numerous historical references, culled from the archives of China, Phœnicia, Greece, Egypt, India, and elsewhere, and a very complete account of the research of modern physicists, he proceeds to give the results of the experiments made by himself. His first aim seems to have been to produce artificial magnets by methods as nearly as possible in imitation of what might be supposed to have been the processes that have obtained in nature. He states that he filled a glass tube five inches long and three fourths of an inch in diameter with pure iron filings, after he had wet them with a thin solution of lime. The ends of the tube were closed with glass stoppers. After the contents had been exposed to a slight warmth for two days, thereby becoming thoroughly dried, it was closely wrapped around with insulated copper wire through which a pretty strong current of electricity was allowed to pass. In ten minutes, during which time the tube had become slightly warm through the influence of the electric current, it was removed from the spiral and cooled. For days and days after that, whenever the tube was suspended by a thread, it was found to be as magnetic as a strong magnet. A considerable time after the tube was carefully broken and separated from its contents, whereby there was obtained a solid, pretty light, very active magnetic cylinder, in which the iron filings had been in great part converted into oxide of iron. Another cylinder, prepared in the same way and broken into very small pieces, showed a similar magnetic polarity, which it even now preserves after a lapse of twenty-five years.—*Bulletin Soc. Imp. des Naturalistes, Moscow*, 1874, 310.

THE DISTRIBUTION OF MAGNETISM IN A MAGNET.

The investigations by Jamin on the distribution of magnetism in solid and compound magnets have already been fully noticed by us; the latest paper on this subject is by Professor Rowland, of the John Hopkins University at Baltimore, who states that some investigations of his own made in 1870 and 1871, and which have not been published as yet owing to reasons beyond his control, bear directly upon the points investigated by Jamin and others, and he has therefore begun the publication of them in full. He begins by giving the mathematical theory of the distribution of magnetism. His formula may be considered, he says, simply as the development of Faraday's idea of the analogy between the magnet and the voltaic battery immersed in water, and are similar to those of Jamin and Green, but have the advantage of being obtained in a more simple manner than Green's, and, what is of more consequence, all the limitations are made at once, after which the solution is exact; so that, although they are only approximate, yet we know just where they should differ from experiment.

One of the most novel features of the observational part of Professor Rowland's work consists in the method itself, by means of which he measures the intensity of the magnetism at any portion of the magnet. This consists in sliding a small coil of wire which just fits the bar, and is also very narrow, along the bar, inch by inch, and noting the induced current by the deflection of the galvanometer needle. —*American Journal of Science and Arts*, X., 325.

ON THE DISTRIBUTION OF MAGNETISM IN SHORT THICK MAGNETS.

A second series of investigations has been made by Jamin in reference to the distribution of magnetism in compound magnets having a finite length. The formula for this case can be deduced theoretically from those of his previous papers, as applicable to bars of infinite length; and having taken this step, it remained only for him to verify this law by actual experiments. This he has done by employing, as before, bundles composed of from one to twenty thin steel plates, the dimension of each plate being the same as before. The agreement of the formulas with the observations has been perfectly satisfactory; and, as he remarks, "we are now enabled to construct to order a magnet containing any given quantity of magnetism, or affording at its extremity any desired intensity." We can also calculate the position of the poles and the magnetic moment of such a magnet, and can determine the maximum limit of its magnetism. There remains, however, still to be examined the question of the variation of magnetic power with temperature, and with the chemical or physical structure of the metal.—6 *B*, LXXXI.

ON MAGNETS COMPOSED OF COMPRESSED POWDER.

In connection with his researches on magnetism, Jamin states that he has repeated some interesting observations published in 1836 by De Haldat. He has, viz., by compressing strongly, by means of a small hydraulic press, some iron filings in a tube, found that when they commenced to solidify the polarity increased considerably, and continued increasing with the pressure. In order to be sure of the nature of the original powder, he prepared some from pure soft iron which had no appreciable magnetic force, but the resulting phenomena were as before. We have, then, the case of a metal which has no coercitive force when it is continuous, but which acquires such, and that to a great degree, when it is reduced into discontinuous small fragments, and when these are joined by pressure. Is it not, then, to this discontinuity that it is necessary to attribute the observed polarity, and does not this experiment explain the magnetic force of steel? The question thus put reminds one of Jamin's previous experiments, which have shown that the distribution of magnetism within a magnet can only be explained by considering the latter as composed of very small filamentary magnetic elements having opposite poles, and acting upon each other. The present pressure experiments seem to show that these filaments may possibly be identical with the small fragments of iron filings, or with the small crystals agglomerated together in the case of steel. A further investigation of this subject, by means of a very powerful and accurate hydraulic press, is promised by the distinguished author.—6 *B*, LXXXI., 205.

ON THE DISTRIBUTION OF MAGNETISM IN BUNDLES OF INFINITELY LONG, VERY THIN PLATES OF IRON.

M. Jamin states that, having investigated the distribution of magnetism in infinitely long thin plates of iron, and found it represented by an exponential formula whose constants depend respectively upon the nature and the temperature of the iron or steel, he has now continued his researches by combining any number whatever of such plates, but still considering the case when the bundle is infinitely long with reference to its other dimensions. The first result of this study was to show that a saturated magnet is a bundle of elementary magnetic threads inclosed within their average section as by a band, but expanded toward their extremities. The number of these bundles depends only upon the mean section, provided that their polar surfaces are sufficiently expanded. The total quantity of magnetism in the thin plates is equal to the product of its section by a constant factor, which factor is independent of the length, and is proportional to the thickness of the plate, and also to its breadth. These three laws can be easily demonstrated by determining the magnetic force of plates of variable length, breadth, and thickness. By means of a number of bars having a length of ten inches and a breadth of less than one inch, Jamin formed a compound magnet whose dimensions were alterable at pleasure; this has enabled him to test his laws under a very wide range of circumstances, and it was demonstrated thereby that by superposing these plates to any number whatever, and in any direction whatever, the resulting bundle always contains the algebraic sum of the magnetism of the various elements. This, however, is only true when the bundle is so proportioned that its length may be considered as infinite. By combining fifty such plates, as nearly identical as possible, in different manners, he has very successfully investigated the law of distribution of the total magnetism; and finds that it can be exactly represented by an exponential formula similar to that which he has already shown to obtain in reference to simple plates, and which therefore enables one, knowing certain constants which may easily be determined, to calculate the magnetism at any point of any magnet whatever.—6 *B*, LXXXI., 11, 177.

MAGNETIC OBSERVATIONS IN THE INDIAN OCEAN.

It is noted that the magnetic observations made at twelve stations occupied by transit of Venus parties are all due to the observers trained at Stonyhurst. At each of these stations, for about five months, observations were made every two hours during the day and night; and these will, it is hoped, afford a fair knowledge of the spring and summer weather in the Pacific and Indian Oceans.—*Quart. Jour. British Met. Soc.*, 1876, 81–87.

MAGNETIC MAP OF FRANCE.

The *Annuaire* of the Bureau of Longitudes for 1876 contains a magnetic map of France, prepared by Marié Davy. It is the intention hereafter to annually publish this same map with such corrections as it needs from time to time. It would be very highly appreciated in America, if our own Nautical Almanac Office would add a similar work, showing the distribution of terrestrial magnetism in the United States, to its present publication, which, while principally astronomical, contains something having reference to the tides and to terrestrial physics.—*Annuaire Bureau of Longitudes*, 1876, 326.

ON THE DEVIATION OF THE COMPASS.

Belavenetz, as the Director of the Compass Observatory of Cronstadt, has invented an apparatus for annuling the influence upon the ship's compass of the permanent and induced magnetism of the ship. The application of this apparatus has therefore the result of forcing the ship's compass to indicate always the true meridian, no matter in what direction the ship may head. The arrangement of the device by Belavenetz, in fact, completely eliminates the semicircular and the quadrantal deviations, so that, by means of horizontal and vertical magnets and powerful iron cylinders, the deviation on board of a ship, the inclination, and the total magnetic force are brought back to their normal values for the portion of the earth in which the ship happens to be.—*Austrian Hydrog. Mitth.*

DEVIATION OF THE COMPASS IN IRON SHIPS.

It is now tolerably well ascertained that some of the sudden and heretofore unaccountable variations in the deviation of the compass needle on board of iron ships are caused by the unequal and varying diffusion of heat over the iron hull. It is affirmed that to unsuspected changes in the indications of the needle, arising from the cause above named, frequent errors in reckoning, and perhaps shipwreck, may be justly ascribed. Sudden changes, amounting to as much as five degrees, have occasionally been noticed on vessels of this kind on the American coasts, which can only be reasonably explained upon the foregoing supposition. In the instances alluded to the variations were attributed to changes in the hull, caused by the passage of the vessel from cold to warm water, or the reverse, as, for example, into and out of the Gulf Stream; or to the effect of the sun's heating influence being unequally distributed, striking on one side only, and perhaps subsequently changing to the other.—20 *D*, *Oct.* 7, 1875, 15.

NEW RELATION BETWEEN ELECTRICITY AND LIGHT.

A new relation between electricity and light has been announced by Dr. Kerr, of Glasgow, who finds that when glass, which in its normal condition is a singly refracting medium, is properly subjected to the action of electrostatic force, it assumes a new molecular structure, and thus acquires the property of double refraction. A Ruhmkorff's induction apparatus was employed, and a block of plate-glass served as the dielectric medium, while polarized light was transmitted through the glass in a direction perpendicular to the lines of electric force. Under these conditions the glass acts as though it has suffered compression along the lines of force, or, in other words, it becomes a negative uniaxial medium. Similar results were obtained with other dielectrics, the action of resin, however, being contrary to that of glass, or positive.—15 *A*, *November* 20, 676.

ELECTRICITY FROM DIPPING METALS IN FLUIDS.

If two similar pieces of metal are simultaneously immersed in a fluid, they give no electric current; but if dipped successively, an electric current is observed, as has been long known. In fact, the electro-motive force, at the separating surface of the metal and the fluid, varies according to the time that they have been in contact with each other. This variation of the electro-motive force is, in many cases, purely a secondary phenomenon, in that by chemical means a foreign substance is formed between the metal and the fluid, which greatly changes the separating surface, and gives rise to a chemical polarization. Electric currents are also, in these cases, due to the accidental formation of foreign substances, and to the exposure of the metal to the atmosphere, or to contact with the fingers. But even when foreign substances and chemical influences are excluded in the most perfect manner possible, as, for example, when platinum or gold, is dipped in water, movements of the needle are still visible; and it has been suspected that the air which is retained in contact with the surface of the metal, or perhaps the method that has been employed to cleanse the platinum or gold may have had an important influence in bringing about an electric current. Quincke has recently subjected this phenomenon to careful investigation, and has observed that the strength of the electric current increases with the increasing resistance of the column of fluid between the electrodes; that it increases with the decreasing strength of the concentration of the salt solution that may be employed; that it has no relation to the capillary constants of the fluids employed, and that it originates probably in the change in the molecular condition of those portions of the fluids which are in the neighborhood of the metallic surfaces.—19 *C*, VIII., 71.

PRIORITY OF DISCOVERY OF THE PRINCIPLE OF THE GRAMME MACHINE.

According to a recent lecture of Dr. Andrews, the celebrated magneto-electric machine of Gramme, which is the only one that gives a continuous electric current, was preceded by the publication in 1865, by Dr. Pacinotti, of Florence, of a machine for a similar purpose, whose essential feature was in the novel form of the armature, by means of which continuous electrical currents, always in the same direction, could be obtained from a magnet. Pacinotti does not indeed appear to have constructed the machine described by himself, but states that he verified the correctness of his views, and satisfied himself that a magneto-electric machine could be constructed which would give induced currents, all in the same direction. The ring armature employed by him was not essentially different from that invented by Gramme, although, according to Professor Andrews, through a serious blunder in the construction of his machine, Pacinotti could not possibly have attained M. Gramme's results.

THE GRAMME ELECTRIC MACHINE.

The Gramme magneto-electric machine has for some time been employed for supplying light at the Houses of Parliament in London, and an idea of its power may be gathered from the fact that it is worked by a steam-engine at a distance of 480 feet from the point at which the light is produced, the current being conducted thither by copper wires one sixth of an inch in diameter. The magnets in the machine are arranged upon three massive rectangular blocks, and make 389 revolutions per minute, at an expense of 2$\frac{2}{3}$ horse-power, and give a light equal to over 3000 of the English standard candles.

A NEW THEORY OF GALVANIC RESISTANCE.

According to Herwig, the resistance to a galvanic current offered by any metallic conductor is a subject that has as yet been but little understood. The phenomena themselves consist principally in the following: (1) The nearly uniform rate at which the resistance increases with the temperature; (2) metals in a liquid condition have a greater resistance than as solids at the same temperature; (3) for liquid metals the resistance increases with the temperature, but to a much less degree than for solids; (4) the transition from solid to fluid, as well as that from fluid to vaporous condition, is accompanied with an increase of resistance; (5) in the case of saturated metallic vapors a diminution of the resistance is produced by an elevation of temperature; (6) a greater resistance is found at the boundary surface between fluid and solid portions of the same metal than within the vaporous atmosphere itself.—19 *C*, VIII., 71.

ON THE INFLUENCE OF LIGHT UPON THE CONDUCTIVITY OF CRYSTALLINE SELENIUM.

Dr. Werner Siemens writes that he has investigated the conductivity of selenium as affected by light. He states that although the selenium has an extraordinarily irregular absorptive power, and although consequently the increase in its conductivity by the action of light is very variable, yet by soldering two pieces of flat spiral wire at a distance of one millimeter from each other between two pieces of mica, he was able to construct an extremely delicate measure of light. Dark heat rays have no direct influence in this arrangement upon the conductivity; warming the selenium diminishes the conductivity. Diffuse daylight doubles the conducting power, but direct sunlight increases this power tenfold; and he states that he hopes to be able, by means of this mineral, to construct a reliable photometer.—*Monatsb. k. Akad. der Wissens., Berlin*, 1875, 280.

CONDUCTION OF ELECTRICITY BY COMPOUNDS OF SULPHUR.

According to the observations of Herwig, the resistance which iron and steel offer to the passage of the galvanic current varies with the direction, intensity, and duration of the current itself. Similar phenomena have now been made known from the observations of Braun in reference to a large number of both natural and artificial compounds of sulphur; the effects in question amount to thirty per cent. of their entire value, so that of the existence of these differences there can be no question. A connection between the crystallographic peculiarities of the minerals and the direction of maximum or minimum galvanic resistance is not clearly made out, although indicated in some cases.—19 *C*, VIII., 95.

ON THE GLOW DUE TO GALVANIC CURRENTS.

The experiments made by Müller in Freiburg a few years ago gave the first correct information with respect to the law which regulates the glowing of wires through which a current of galvanism is passing. Müller's experiments and methods have been the subject of a communication to the Bohemian Academy of Sciences by Professor Von Waltenhofen, who states that Müller's results seem to accord less accurately with theoretical considerations than the results of Zöllner's investigations of the same point. The principal results of Müller's observations were expressed by him in formulæ or curves which showed that for a given length of wire of a given thickness and for a given strength of battery there exists a maximum intensity of the glow; and, again, if the wire of given length must be made to glow, the thickness of the wire must lie between two well-defined limits.

Von Waltenhofen shows, in addition to this, that, at least for the more intense stages of glow, we are always justified in considering the specific resistance of the glowing wire as nearly constant.—*Sitzb. k. Akad. der Wissens.*, 1874, 79.

CURIOUS ELECTRICAL LIGHT.

Dr. James Blake states that on the evening of the 30th of September, 1874, at Placerville, El Dorado County, California, while watching the lightning continuously flashing in the southwest horizon, he observed, at a quarter past seven, a luminous appearance apparently proceeding from the crest of the range of mountains about six miles distant to the southwest, which was visible through an arc horizontally of about 15°, and extended about 8° above the horizon. The light lasted for about a quarter of an hour, was undoubtedly electrical, appeared like a fine display of the aurora, and may have been due to the silent escape of electricity from the crest of the ridge. The storm in question was the greatest electrical disturbance recorded since the settlement of the country.—*Proceed. Cal. Acad. of Science*, V., 406.

PHENOMENA ATTENDING ELECTRIC DISCHARGES.

Schneebeli, in a short note on the electric discharge, accompanied with diagrams showing the zigzag and other peculiarities of the discharge, states that the method which he pursues for fixing these figures consists in employing a paper wet upon one side with a solution of gum lac in alcohol, which permeates the paper, and fixes without changing its outlines the blackened trace on the other side of the paper formed by the electric discharge itself. That part of the figure made by the discharge which is near the positive pole is traversed by very fine lines, and the isolated branches shoot from the main stem in all directions. That part of the figure of the discharge formed at the negative pole shows these fine lines only in the immediate neighborhood of the pole, and has no isolated branches. It will be remembered that the figures called Lichtenberg figures show also a very remarkable difference between the two electricities. The most instructive peculiarity of Schneebeli's figures is found in a very well-marked point near the centre of the figure, and separating the positive from the negative discharge. This central point has every appearance of being that in which the layers of air meet, after moving in opposite directions from either pole toward the centre. When very strong electric discharges are employed, this peculiar meeting-point is obscured, but becomes very distinctly marked when feebler discharges are made.—*Bulletin Soc. des Sciences Naturelles, Neuchatel, May,* 1875.

DUPLEX TELEGRAPHY.

In some historical notes on the development of duplex telegraphy, Mr. Cracknell, the superintendent of electric telegraphs in New South Wales, states that this art, which consists essentially in working in two opposite directions on one wire simultaneously, was first tried as far back as in 1853, by Dr. Gintel, the director-general of telegraphs in Austria, on the line from Vienna to Prague. In his arrangement the compensating currents of electricity could not well be controlled, and the system was not found to be a practical success, although experimentally it worked beautifully. In 1854 Frecher, Siemens, and Halske devised a modification of the duplex method by adopting a somewhat complicated system of resistance coils. These were the first Morse instruments used on telegraph lines in New South Wales, in January, 1858. They could not be made to work satisfactorily, and were reduced to single-acting Miller's recorders. Siemens and Halske's arrangement was worked on what is called the differential principle. Stearns' duplex system, lately perfected in America, and now attracting the attention of telegraph engineers in most parts of the world, is on a principle which is dependent on producing an equality of tensions, which are sometimes called potentials. With this system the relay coils are wound with double wires. It has proved a great success, partly by improvements on old principles, but more particularly in consequence of the introduction of more perfect appliances, since Gintel's and Siemens and Halske's inventions.—*Transactions Roy. Soc. of New South Wales*, 1874, 71.

THE DOUBLE-BALANCE METHOD IN DUPLEX TELEGRAPHY.

Louis Schwendler, electrician in charge of the telegraph lines of India, has communicated to the Asiatic Society of Bengal a memoir on the general theory of duplex telegraphy, and has investigated with great detail the conditions necessary to the successful use of the bridge method under two suppositions: first, that the line is in perfect insulation, and, second, that the line has appreciable leakage; the latter being of course the actual case in practice. He first shows that, in order to obtain the best results in both cases, the resistances and the currents must have certain relations to each other, such that there should be two balances, viz., a balance in one branch for the receiving current, and a balance in another branch for the outgoing current. This method elaborated by him, and which he calls the double-balance method, fulfills the following conditions, which he states are necessary, and are sufficient to place duplex telegraphy on a par with single telegraphy. First, any variation in the resistance of the line has the least possible disturbing effect on the receiving instrument. Secondly, any disturbance can be eliminated by a single adjustment without disturbing the balance in a distant station. Thirdly, the maximum magnetic moment of the receiving instrument is obtained and employed. Fourthly, a maximum working current is available. This double-balance method was introduced by him first in June, 1874, between Bombay and Calcutta, and has since then been working so satisfactorily even during the worst time of the year, viz., the southwest monsoon, that Colonel Robinson, director-general of the telegraphs in India, has decided to introduce this duplex method also on the other long main lines of India.—*Journal Asiatic Society of Bengal*, 1874, 218.

SCHWENDLER'S METHOD IN DUPLEX TELEGRAPHY.

In the annual address of the President of the Asiatic Society of Bengal, it is said that the double-balance method in duplex telegraphy, as invented and perfected by Mr. Schwendler, of Calcutta, was introduced, on the 28th of January, 1875, on one of the main lines from Calcutta to Bombay, 1600 miles; since which time, and in the worst season—the southwest monsoon—the method has worked with great regularity and speed. In a few days another main line from Bombay to Madras will be worked; and it is probable that before the lapse of the current year (1875) the whole of the main traffic in India, from Calcutta to Rangoon included, will be carried on by this system. The method is also practicable on cables, as shown by the experiments with the cable from Bombay to Aden, 1800 miles long. It has been mathematically demonstrated and confirmed by practice that Schwendler's double-balance method involves all the necessary conditions to bring duplex telegraphy on a par with single telegraphy.—*Proceedings Asiatic Society of Bengal, Feb.*, 1875.

NEW ELECTRIC APPARATUS FOR RAILROADS.

Preece's single-wire block signaling instruments are in extensive use in England. They possess one special and important advantage which no other single-wire system has: that the consentaneous action of the two signal-men at the station in advance and in the rear is necessary in order to lower the semaphore to the point which indicates "all clear," thus avoiding the production of a false safety signal from any accidental current. A part of the same apparatus consists in the single repeater which repeats back electrically the movements of a signal which may be out of sight of the man who works it.—*Forty-second Ann. Rep. of the Royal Cornwall Polytechnic Society*, 80.

EAST INDIAN TELEGRAPHY.

The reports from the Indo-European Telegraph Company say that the average time in transit between London and India, *via* Teheran, of all outward messages to India, including the messages for Penang, Singapore, China, Japan, Java, and Australia, for the week ending October 8th, was one hour and sixteen minutes.—*Engineer*, XL., No. 1034, 281.

ATMOSPHERIC ELECTRICITY.

Professor Van der Mensbrugghe, in a memoir on the application of thermo-dynamics to the study of the variations of the potential of liquid surfaces, is led to a conclusion of capital importance to meteorology. His equations, namely, seem to prove rigorously that any change in the surface of the liquid gives rise to a change of temperature, and, if the circuit is closed, to a thermo-electric current. His experiments show that, on the one hand, the water of the ocean under the action of the sun, being submitted to a continual evaporation, must affect the calorific and the electric state of the earth, and develop constant thermo-electric currents. On the other hand, the enormous quantity of vapor which is lifted into the atmosphere is there subjected to incessant variations in respect to the surfaces of contact with the air of its vesicles, raindrops, etc. Its reduction from a state of extreme and almost molecular tenuity to a state where, by sudden condensation it forms larger raindrops, enables it to actually produce enormous quantities of electricity, until the drops fall in turn upon the surface of the globe from which they were elevated. Thus we have at once, on the one hand, the existence of a constant source of thermo-electricity circulating around the earth, and on the other hand a permanent cause of atmospheric electricity. — *Bulletin Acad. Royal des Sciences de Belgique, Bruxelles*, 1876, 782.

LIGHTNING FROM A CLEAR SKY.

The rare phenomenon of a stroke of lightning from a clear sky was observed on the 3d of July, at 4 P.M., at Senftenburg, Saxony. At that time a thunder-storm was observed so far distant that some thirteen to fifteen seconds elapsed between the flashes and the thunder, when suddenly in the clear sky, in the immediate neighborhood of the observer, Dr. Roch, a blinding flash and fearful thunder occurred. Especially noteworthy was it that this abnormal flash put an end to all the distant lightning and thunder; and the storm clouds very quickly disappeared from the heavens, which retained during the night their original purity.—*Sitzb. Naturw. Gesells. "Isis," Dresden, December*, 1875, 118.

PROTECTION AGAINST LIGHTNING STROKES.

In his annual address as President of the Meteorological Society, Dr. R. J. Mann states that Professor Melsens, of Brussels, has been for some time engaged in an interesting series of experiments as to the capacity of copper and iron to transmit electric force. He states that Melsens demonstrates that an electric discharge does not of necessity pursue the shortest and easiest path. As to the density of copper and iron when subjected to the disintegrating dispersion of electrical discharges of high tension, he states that under the same circumstances the copper wire used as a conductor for a charge from fifteen very large Leyden jars is completely dissipated into a trail of black dust, while the iron wire is not even broken under the same circumstances, but is simply beaded along its entire length by a series of successive protuberances. Professor Melsens has adapted a very elaborate system of about 428 points belonging to as many iron rods to the protection of the Hôtel de Ville at Brussels from lightning. The rods are collected ultimately into a group of eighteen larger stems, which are soldered into a continuous metallic mass, from which they ultimately diverge underground to the water-pipes, gas-pipes, and moist ground; securing a triple earth contact which would seem to present perfect assurance against danger. Melsens entertains the magnificent design of protecting the entire town of Brussels in one continuous system of rods, so that by securing a very ample development of earth contacts beneath, and air terminals above, no possible danger can be apprehended for the whole surface of the town.—*Quarterly Journal British Meteorological Society*, 1876, 48.

LIGHTNING-CONDUCTORS.

Dr. R. J. Mann states that the following conditions are indispensable for protection against lightning: first, ample dimension and unbroken continuity in the lightning-rod; second, free earth contacts, with frequent examination by galvanometers of the condition of these to prove that there is no gradual impairment through the operation of chemical erosion; third, the employment of points enough to dominate all parts of the building; fourth, the addition of terminal points to the conducting system wherever any part of the structure of the building comes near to the limiting surface of a conical space, having the main point of the conductor for its height, and a breadth equal to twice the height of that point from the earth for the diameter of its base; fifth, the avoidance of all less elevated conducting divergences within striking distance of the conductor, and especially such dangerous divergences of this character as gas-pipes connecting with the general gas-main, and therefore forming good earth contacts.—12 *A*, XII., 80.

SURFACE TENSION OF LIQUIDS.

Cintolesi has experimented on the relation which the surface tensions of various liquids sustain to each other under various conditions. Of these conditions, temperature is one of the most important. A drop of olive, almond, or castor oil placed upon distilled water at 100° retains its lenticular form, and does not spread into a film. At 65° the drop begins to flatten, and at 50° the film forms, but is silver white, showing no color. If, however, water at 100° be allowed to fall on a surface of cold oil, a membrane is formed, which at first shows colored rings, but which soon contracts into a drop as it cools. Examining solutions of various salts in the cold, he observed the well-known wide differences of behavior with different oils. Repeating the experiments at 40°, he found that even so slight an elevation of temperature completely reversed the phenomena in many cases, making the surface tension of the solution less than that of the oil. He used alcohol, ether, and benzene, copaiba balsam, the fixed oils of olive, castor, almond, and linseed, and the ethereal oils of cinnamon, clove, mint, lavender, and bitter almonds. With cinnamon and clove oils there was at first a spreading out into a film; then the film was ruptured, forming numerous flat drops, which became round, and showed phenomena resembling ebullition, finally breaking up into smaller particles. The influence of the vapors of certain liquids on these films is often remarkable. A drop of ammonia on the end of a rod, when brought near an oil-drop resting quietly on the surface of water, causes its rapid expansion. If the experiment be made on a glass disk covered with a layer of water on which the oil-drop rests, the expansion begins when the rod is six or seven centimeters distant, and on closer approach the water is driven out and the oil-drop falls to the glass. Examining the phenomena under the microscope, Cintolesi found, 1st, that the films always contain swellings, which produce holes by their rupture, thus causing the parting of the films; 2d, that the ebullition phenomenon was present in all the cases observed; 3d, that decrease of pressure or movement of the air in contact with the surface accelerated the formation of the film; 4th, that heat may increase the rapidity of expansion, or may stop it entirely, according to the conditions; 5th, that the ebullition disappears as the development of the film is more rapid; 6th, that no contractile liquid surface is necessary for this expansion, since it may take place within a mass of liquid or on the surface of solids. Closer microscopical examination showed that whenever a drop expands to a film, there is a development of gas, appearing to the eye under the form of round swellings, which move under the film from the thinner border to the centre, and reveal their true nature if the film becomes thin enough to break and allow them to be diffused. The phenomenon is well seen when almond oil is placed on a glass disk. Moreover, the appearance of ebullition above referred to arises from this development of gas, the two or three bubbles first formed uniting, and becoming the centres of action toward which the other bubbles tend. But as the larger bubbles do not continue to increase in size with the arriving bubbles, the gas would seem to be only the vapor of the expanded liquid. The bursting of these gaseous accumulations produces rents in the films, the spreading out of which, the author believes, is due to the fact that the gaseous molecules, moving in all directions, force the liquid molecules out horizontally in all directions, *i. e.*, along the surface.

The previous researches of Mensbrugghe, of J. Thomson, and especially of Tomlinson, had vastly extended our knowledge of the action of the surface-tensions of various liquids upon each other. But it appears that Cintolesi has reached a new manifestation of the phenomena which, though doubtless always accompanying surface-tension, is independent of it in many cases.—18 *A*, *October* 6 *and* 20, 1876, 85, 136.

METALLIC FILTRATION.

Professor Lampadius, of Freiberg, concluding that at a certain low temperature of fusion the metallic impurities present in the more easily fusible metals would separate, partially as such, and partially as definite crystalline compounds, and float in the fused mass, from which they could be removed by filtration, made experiments in this direction, which were so far successful that the expected definite compounds were found upon the filter, though the metallic filtrate was still very impure. The filter was made of quartz sand, slag, etc., which was not wet by the molten metal. Subsequently Carter, in attempting to apply this method to the purification of Bohemian tin, as a commercial operation, sought to use for a filter a material which should be wet by the material to be purified, and at the same time should not be dissolved by it. For this purpose he chose iron, which, while it has a comparatively high temperature of fusion, has a strong adhesion to tin, as is evident in the tinned iron plate of commerce. Five hundred strips of tinned iron, as thin as paper, about 0.6 of an inch long, and one fourth as broad, were packed tightly in a square iron frame by the aid of wedges, and the frame was then luted into a suitable opening in the bottom of a graphite crucible. The tin, melted in a second crucible, was allowed to cool until the separation of fine crystals on the surface was noticed, the thickening metallic mass being then poured into the filtering crucible, when the still fluid pure metal passed through and a pasty magma was left, in which iron, arsenic, and copper, concentrated to a great degree, were found combined with tin, while the filtered tin proved to be almost chemically pure. Fifty hundred-weight were purified in the crucible described. Other forms and other materials for filters are suggested, and other possible applications of the method, as in the separation of silver from lead containing the former metal.—18 *A*, *October* 6, 1876, 89.

RESISTANCE OF THE ELECTRIC ARC.

Ayrton and Perry, of the Imperial College of Engineers, Tokio, Japan, desiring to determine theoretically the best arrangement of cells for the production of the electric light, have measured, as a necessary preliminary, the resistance of the electric arc. The first experiments were made with sixty new Grove cells—the immersed platinum plate being thirteen, and the zinc plate twenty-five square inches—used with a Duboscq regulator. The known resistance introduced consisted of many meters of bare copper-wire hanging in the room, the thickness of the wire being sufficiently great to prevent any rise of temperature in it. By means of a Thomson quadrant electrometer the difference of potential between the carbon points was measured, and compared with that between the wire of known resistance. Since at any given moment the same current is flowing through the electric arc and the wire, the differences of potentials are proportional to the resistances. The alternate measurements succeeded each other closely, and were repeated many times. The resistance obtained never exceeded twenty ohms, and had an average of about twelve ohms; the variation being considerable even when the light was apparently steady. In a second series of experiments, eighty Grove cells joined in series, which had been in use occasionally for three hours after being set up, were connected with a differential galvanometer, in one circuit of which was a high resistance, in the other the electric arc, each galvanometer-coil being shunted with a wire of small resistance. When balance was obtained, the resistance of the arc, which, as before, varied greatly, never exceeded twenty-nine ohms, and averaged twenty ohms. From these results the authors draw the important conclusion that with such cells as they used no attempt should be made to join any of the cells in parallel circuit until at least two hundred have been joined in series; for if the resistance of each cell is about 0.2 ohm, two hundred of them would have a resistance of forty ohms—a resistance certainly less than double the electric arc for that battery corresponding with brightest light. Moreover, the authors have previously shown that the cells of a battery should be joined in series until the resistance of the battery is double the external resistance, at which point the battery should be joined in two rows, each containing half the number of cells in series, and the two rows connected in parallel circuit.—12 *A*, *October* 19, 1876, 544.

ACTION OF LIGHT ON EBONITE.

Herbert McLeod has called attention to the production of acid drops upon surfaces of ebonite or vulcanite exposed to the air by the action of light. It has long been known that the insulation of electrical apparatus made of this material is impaired by the formation of this conducting layer, which is sulphuric acid due to the oxidation of the sulphur used in vulcanizing the rubber. It now appears that the production of ozone by electric sparks is not, as Wright supposed, the sole cause of the phenomenon. A plate of ebonite polished on both sides was sawed into four strips, each 52 mm. by 22 mm. by 8.5 mm., exposing therefore about 3500 sq. mm. of surface. One half of each piece was varnished with shellac. Two of these pieces were placed in wide test-tubes plugged with cotton-wool, and the other two were sealed hermetically in similar tubes. One of the sealed tubes and one plugged with cotton-wool were placed in a dark drawer, and the other pair exposed to light in the laboratory, and during the latter part of the experiment to direct sunlight. The experiment was commenced on December 26, 1874, and after some time minute drops of liquid were perceived on the ebonite exposed to light and air, the remaining three pieces retaining their original appearance. Between September 1st and 21st of this year the sealed tube exposed to light was accidentally broken, so that for a period of less than three weeks the ebonite in it was exposed to both light and air. On September 21st the tubes were opened, the ebonite washed with water, and the amount of acid determined by standard solution of caustic soda. No trace of acid could be detected on either of the pieces of ebonite which had been kept in the dark. On the one which had been exposed to light in the closed tube 0.343 milligrammes of sulphuric acid was found, and on that exposed to light and air 2.646 milligrammes. In confirmation of these results, the author notices an excellent instance of the action of light on vulcanite which occurred in the laboratory of Warren De la Rue. An apparatus with an ebonite base with three adjusting screws was standing at some distance from a window. The surface of the plate was covered with a fine dew of an acid liquid, except at the parts where the shadows of the heads of the screws fell. The surface at these places completely retained its original polish.—12 *A*, *October* 12, 1876, 525.

AMALGAMATION OF IRON.

In a paper read before the American Chemical Society, Casamajor describes a new method of amalgamating iron, which promises to render this metal useful for many novel purposes. That iron may be made to combine with mercury is a fact discovered by Sir Humphrey Davy, whose process consists in immersing sodium amalgam in a saturated solution of ferrous chloride or sulphate. Cailletet, in 1857, showed that iron may be coated with mercury by means of ammonium amalgam, or by means of electrolysis. As the iron in both cases does not amalgamate till hydrogen appears, Cailletet concludes that the effect is due to the nascent hydrogen. Desiring to test the soundness of Cailletet's theory, Casamajor placed mercury in a beaker glass, covered it with acidulated water, and introduced a horse-shoe nail of Norway iron. Though a moderate escape of hydrogen took place, no trace of amalgamation appeared, even in twenty-four hours. Having to amalgamate a piece of zinc for another experiment, he placed the zinc in the beaker glass with the iron. The evolution of hydrogen from the nail increased at once very perceptibly, and after a short time the nail was found thoroughly amalgamated. Hence all that is necessary is to place the iron in acidulated water in contact with the mercury, and to add a few pieces of zinc; in a few minutes the iron will be coated with mercury. Since the zinc is attacked only when a more negative metal touches it, the consumption is very slight. The coating of mercury thus produced is not a superficial layer; the mercury sinks into the metal, modifying its physical and chemical properties, as is seen on fracture. No alteration in the tenacity of soft iron is observed, while hard-tempered steel has its brittleness much increased. In the voltaic circuit the amalgamated plate is positive to an unamalgamated one, and hence is more rapidly attacked. The quantity of mercury combined with the iron is very small. A piece of sheet-iron, presenting on both sides a total surface of three square inches, was amalgamated, and left to soak in mercury for over an hour. The mercury was then wiped off very thoroughly and the piece of sheet-iron weighed. The increase over the original weight was three centigrammes, which showed an absorption of mercury equal to a little over four centigrammes per square inch. The increase in weight of this thin sheet of iron was only three and a half per cent.; yet the fracture was silvery, and globules of mercury stood on the rough edge of the fracture. Platinum, palladium, aluminum, nickel, and cobalt, all take mercury under the same conditions as iron. Aluminum, however, shortly after amalgamation, becomes hot, the mercury seems to boil, and the aluminum remains covered with a chalky crust, on removing which the metal is found beneath without a sign of amalgamation.—*Proc. Am. Chem. Soc.*, I, 1876, 49.

MUSICAL SAND.

In a communication to the California Academy of Sciences, Frink has stated that in order to ascertain, if possible, the cause of the sound that is produced by the musical sand from Kauai, previously exhibited to the Academy, he had investigated its structure under the microscope, and believed that the facts he had ascertained fully explain the manner in which the sound is produced. As the grains of sand, though small, are quite opaque, it was necessary to prepare them so that they should be sufficiently transparent to render their structure visible. This was effected by fastening them to a glass slide, and grinding them down until one flat surface was obtained. The grains were found to be chiefly composed of portions of small coral and apparently calcareous sponges, and presented under the microscope a most interesting object. The sand contained small black particles, which the microscope showed to be formed principally of crystals of nepheline and magnetic oxide of iron, imbedded in a glassy matrix. These were undoubtedly volcanic sands. The structure of these grains, Frink thinks, explains the reason why sound is emitted when they are set in motion. The motion against one another causes vibrations in their substance, and consequently in the sides of the cavities they contain; and these vibrations being communicated to the air by the cavities under the most favorable conditions for producing sound, the result is the loud noise which is caused when any large mass of sand is set in motion.—*Proc. Cal. Acad. Sci.*, 1876.

CAUSE OF SOUND IN ORGAN-PIPES.

It is stated in the ordinary text-books that in the mouthpiece of the so-called flute pipes of an organ the current of air which causes them to sound breaks against the upper lip into a series of intermittent impulses, by which the air in the pipe is set into vibration. Gonuch, however, who is an organ-builder of Cologne, has thoroughly examined this subject, and has come to quite a different conclusion. He states that when a pipe is sounded, the blast being so arranged as to brush the upper lip of the pipe, the current thus produced carries continually out with it air particles from the interior of the pipe, the particles of course being those which lie nearest to the opening. Though a small portion of the current in passing to the lip goes into the pipe, yet the quantity of air which the current pulls out is considerably greater. Hence then arises, first of all, a rarefaction in the lower layer of air in the pipe. The exterior air now seeks to balance the rarefaction, but it can not at once reach it, either by the upper or the lower opening of the pipe. The air-column at rest in the pipe only yields to the outer atmospheric pressure when the rarefaction has extended to the middle of the pipe, where in the fundamental note of an open pipe the node is formed. At the lower opening of the pipe the blast current of course closes the aperture, and prevents the equilibrium there. Now at the moment in which the rarefaction in the lower part of the pipe has reached such a degree that the pressure of the external air is able to press the blast current inward, an air wave is cut off from the blast current at the upper lip, and a small momentary condensation is the result. This wave is propagated along the pipe, and at the middle it collides with the condensed wave which the pressure of the external air has simultaneously produced in the upper opening of the pipe or the air-column. Thus in the middle of the tube is formed a strong condensation, which may be called the acoustic wave, since from that time forth the peculiar vibration of the column and the phenomenon of sound are produced. It is evident, moreover, that at the moment when an air wave has detached itself from the blast current, and has removed the rarefaction in the lower part of the pipe, the blast current returns to its former condition or direction, and produces again its effect upon the air in the pipe. Again a rarefaction is produced, the blast current is again pressed inward, and with the consequent condensation the return of the acoustic wave of the node of vibration coincides. Thus the hypothetical impulses heretofore assumed are resolved into a pendulous oscillation of the blast current, which has its greatest amplitude at the edge of the upper lip, is dependent on the elasticity of the air-column of the pipe and the pressure of the outer air, and so is subject to the laws of vibration of the air-column.—*Poggendorff's Annalen*, 1876.

OBLITERATION OF ONE SOUND BY ANOTHER.

Mayer, in the eighth series of his researches on acoustics, communicates certain striking results which he has obtained on the obliteration of one sound by another, from which he draws conclusions as novel as they are important. The investigation was suggested by observing the ticks of a watch making five per second, in conjunction with those of a loud-ticking clock making four ticks per second. On regulating the distance of the watch the fifth tick became fainter, until it disappeared entirely. An old silver watch, making four ticks per second, was then made to gain thirty seconds an hour on the clock, so that at every two minutes the ticks of the two coincided. When the watch was held at nine inches from the ear, its ticks were wholly obliterated for three seconds; and when at twenty-four inches, for nine seconds. As the time of coincidence approached, the short ticks of the watch glided tick after tick under the long ticks of the clock, more and more of the duration of each successive watch-tick became extinguished by the tick of the clock, until only the tail end of the short tick of the watch was left audible; and at last even this also crept under the long tick of the clock, and the whole of the ticks of the watch were rendered inaudible for nine seconds, at the end of which time the front or head of the watch-tick protruded beyond the clock-tick, and then slowly grew up into a complete watch-tick as before. Experiments were then made to measure the relative intensity of the two ticks, by placing both successively in the open air during a still night, and observing the distance at which they could be heard. The general result shows that the sensation of the watch-tick is obliterated by a coincident tick of the clock when the intensity of the clock-tick is three times that of the watch-tick. Extending the observations to musical sounds, Mayer observed in general the same phenomena. But he discovered here the new and remarkable fact that a sound higher in pitch than another can not obliterate it, no matter how intense. A curious effect of this law is observed if, while a man reads a sentence over and over again with the same tone and modulation of voice, a c' pipe of 256 double vibrations be strongly sounded; it appears as if two persons were reading together, one with a grave voice (formed by a combination of all the reader's real vocal sounds below c' in pitch), the other with a high-pitched voice, generally squeaky and nasal, and of course disagreeable. This obliteration of higher by lower sounds, the author believes, has an important bearing on orchestral music. In the first place it will require the conductor of the orchestra to change his position to one nearer the midst of the audience. In the second, it will require a study of the relative intensity of the components of typical musical tones used in orchestral performances, so that those can be heard which the composer desires should be.—4 *D*, *November*, 1876, 329.

NEW METALLIC PYROMETER.

Though much improved of late years, pyrometers are not exactly all that could be desired. Hence the frequent appearance of new forms of that most desirable instrument. M. A. F. Huet, of Paris, has recently obtained provisional protection for an invention of this kind, being an instrument consisting of a rod of copper contained in a porcelain tube. The characteristic feature of the invention is said to be the particular arrangement of the bar of copper, which with its porcelain tube is inclosed in the wall of a furnace, into which the porcelain tube penetrates a suitable distance. Outside the furnace the tube terminates in a foot or support screwed down upon a plate. Inside the tube is the rod of copper, which is fixed at the inner end by means of a screw-nut at the end of the tube. This rod is prolonged outside the furnace, and terminates in a fork which embraces the vertical branch of a lever. To avoid all contact of the porcelain socket with the copper rod, an asbestus washer is arranged on each side of the screw-nut which fixes the rod and the socket at one end. To render the action of the heat from the furnace more direct upon the copper rod, small holes are pierced in the part of the socket which is inside the furnace. The lever is free to oscillate on an axis. The extremity of the other branch of the same lever is fastened by a joint to the top of a rod which carries a regulating screw-nut, this being terminated at the bottom by a piston destined to press upon liquid in a cistern in connection with a glass thermometer or siphon tube up which the liquid passes, and indicates upon a gauge the heat of the furnace. The defect of this arrangement, apparently, lies in the fact that, after being submitted to high temperatures, the rod of copper would take up a permanent elongation, and refuse to expand or contract to the desired extent or with the desired accuracy.—18 *A*, 553.

CONDUCTION OF HEAT IN GASES.

The question of the conducting power of gases for heat is one which has received a large share of the attention of eminent physicists. The most recent of these researches is that of Winkelmann, who employed for measurement of the heat-conduction the same method which other observers have used; *i. e.*, he measured the rate of cooling of a thermometric body within a vessel filled with the gas to be examined. The difficulty of these experiments lies in the fact that the cooling is caused not only by the conduction of the gas which surrounds the cooling body, but also by the currents which are set up in the gas, and especially by radiation through it. Winkelmann addressed himself particularly to the task of eliminating these currents and the radiation. He effected this in one case by varying the pressure of the gas between 760 millimeters and one, since with diminishing pressure the action of the gas currents becomes less. In another experiment, he employed various apparatuses in which the cooling body within was always of the same dimensions and the same material, while the outer envelope was varied in size. The value of the radiation was then in all apparatuses the same, while the conduction varied with the size of the outer vessel, and so furnished data by means of which the radiation could be calculated and eliminated. The results obtained with several of the more common gases are as follows:

Gases.	Conductivity.	Gases.	Conductivity.
Air	0.0000525	Nitric oxide	0.0000460
Hydrogen	0.0003325	Carbonic oxide	0.0000510
Carbonic acid	0.0000317	Oxygen	0.0000563
Ethylene	0.0000414	Nitrous oxide	0.0000363
Marsh gas	0.0000647	Nitrogen	0.0009524

The fullest series of experiments were made with air and hydrogen, and the numbers obtained for these gases showed that in air, down to a pressure of one millimeter, the conduction of heat is independent of the pressure. Hydrogen, on the other hand, showed a quite divergent and hitherto unexplained behavior with reference to pressure, the changes of the currents in this gas with different pressures by no means affording an explanation of the observed differences in the velocity of cooling. In proof of this, for example, he states that whereas with a lowering of the pressure from 750 millimeters to 91.4 millimeters, there was a lowering of the value for the velocity of cooling of only 1.4 per cent.; yet that on further diminishing the pressure to 4.7 millimeters, there was a further decrease of 11 per cent., the decrease continuing when the pressure was still further lowered to 1.92 millimeters. Whether the circumstances operating in this case were accidental, or whether these anomalies are due to the properties of the gas itself, can be decided only by further and more exact researches. Besides the above question of simple heat-conduction in gases, Winkelmann also undertook to determine the relation in which heat-conduction stands to the temperature employed. In this investigation he had to employ new apparatus made of glass. He was also obliged to effect the separation of the conduction from the radiation on a different principle from that used in the former measurements. The observations were so arranged that first the time of cooling from 18° to 8° was determined, and then from 118° to 108°. With three apparatuses, very different in their dimensions, the author obtained the temperature coefficients 1.3661, 1.3429, 1.3644, referring to the temperatures 7.4° to 7.6°, and 107.7° to 109°. That is to say, if the heat-conduction at the lower temperature be put equal to one, then at the higher temperature it has the value just given. Besides air and hydrogen, carbonic acid was also examined in these researches. If the latter changes its heat-conduction with the temperature in the same way as air and hydrogen, it is obvious, by combination of the values of hydrogen and carbonic acid, that the same relative numbers should be obtained as those given by hydrogen and air. The values so obtained, however, are altogether smaller, whence it appears that the conduction of carbonic acid is not dependent on temperature in quite the same way as that of hydrogen, but increases more quickly with the temperature. The value of these results in the theory of gases is very considerable.—*Poggendorff's Annalen*, 1876.

CREMATION IN FRANCE.

In December, 1875, a committee was appointed by the Council of Health and Hygiene of the Department of the Seine to consider and report upon the subject of cremation. This committee consisted of MM. Baube, Bouchardat, Boussingault, and Troost, the latter being the *rapporteur*. The report of this committee, after noting that the letter of the Prefect of Police did not suggest any special direction which the investigation should take, states that they confined their attention to the following points: (1) The possibility of effecting the incineration of bodies without production of smell or smoke or deleterious gases; (2) the advantages such incineration might offer as regards salubrity; and (3) the inconveniences it would present as regards criminal investigations. They did not have to concern themselves with the propriety of respecting the celebration of religious ceremonies; that propriety having been recognized by the municipal council, and by the administrative committee which fixed the programme of the competition for the invention of the best process for incinerating dead bodies, or of any other system giving a like result. It is, further, well understood, they say, that incineration would be in no wise obligatory, but simply optional, under conditions to be determined by a special law. With reference to the first question examined by the committee, the report is very brief. They do not doubt that by having recourse to gas furnaces, like those used in metallurgy, a rapid incineration could be had. It would be possible also to obtain, without any admixture of foreign matters, the ashes of bodies subjected to cremation. No fetid odor or smoke would be evolved, these furnaces being essentially smoke-consuming. Thus there would be no danger to public health to be feared. The conditions of the municipal council's programme might therefore be easily fulfilled, except perhaps that of economy, it being evident that until these furnaces can be occupied continuously they can not be operated economically. On the second point examined, the committee say that in their opinion cremation would present advantages over the mode of inhumation in a common graveyard, where insufficient space is reserved for each body. Fetid emanations and the alteration of subterranean waters may, in fact, result where the earth is saturated with organic matter in decomposition, and the air can not penetrate in sufficient quantity to produce a complete combustion. The most serious inconveniences of our present cemeteries, however, disappear where only a limited number of bodies sufficiently separated are contained in properly permeable strata. The land thus used might be returned to agriculture, after having been closed for a number of years; for the bodies buried in permeable soil are subjected to a sort of slow and indirect combustion, which does not present any inconvenience so long as the intermediate and dangerous products do not reach the surface of the ground. On the third point, the report asserts that inhumation presents guarantees for society which are not found in cremation, if the question be considered with reference to the investigation and determination of poisons, the existence of which is often not suspected till long after death. Dividing poisons into two classes, those which cremation would cause to disappear and those which it would not destroy completely, the committee say that in the case of the former class, in which rank all toxical substances of organic origin, and also arsenic, phosphorus, and corrosive sublimate—the very poisons, by the way, most commonly employed—cremation would obliterate all traces of the crime, would thus insure immunity from punishment, and so encourage the repetition of crime. In the case of the second class of poisons, which includes copper and lead, for example, while the metal might be found in the ashes, yet the persons interested would, it is clear, always have the opportunity of dispersing those ashes, or of replacing them with others; so that, in this event, the traces of crime would also be easily obliterated. For these reasons criminals might find in cremation a security which they have not in the present process of inhumation, and which it is important not to afford them, for it would be a source of more serious danger to the population than the insalubrity of cemeteries. The objections thus raised against cremation, however, would disappear if the law required that before any such operation an autopsy of the body should be made and a chemical examination had of its principal organs, so as to ascertain the presence or absence of poison. But these examinations, which have value only when they are conducted in a truly scientific manner, are always delicate, even when the field of investigation has been limited by judicial instructions; and they would become extremely long and troublesome in the absence of any preliminary indication. Moreover, even if it be admitted that they would be conducted with the necessary care and skill so long as the number of cremations is small, it by no means follows that this would be the case when the demands for incineration multiplied.—*Annales de Chimie et de Physique*, V., viii., *August*, 1876, 571.

THE DIETHEROSCOPE.

Professor Luvini, of Turin, exhibited at the Scientific Loan Exhibition in London, and also at the International Exposition at Philadelphia, an instrument on a totally new principle for measuring atmospheric refraction. Its construction is as follows: If one half of a lens be covered, the image produced by it will differ only in brightness from that formed by the uncovered lens. Moreover, if we take two lenses of unequal focal length, and place them at a distance from each other equal to the sum of their focal lengths, the rays emerging from the second will have the same degree of convergence as those entering the first; *i. e.*, the object looked at will appear in its natural size and position. Any agency—such as irregular refraction of the atmosphere—which alters the path of the light from the object to the system of lenses will alter the position of the image formed. If now we have a telescope of such a size that the lenses of the dietheroscope cover half of the aperture of the object-glass, two images of the distant object can be formed—one as seen through the dietheroscope, the other as seen beside it; the latter image being formed by the rays coming directly from the object to the telescope. If the telescope is astronomical the latter image will be reversed, while that transmitted through the dietheroscope will be in its natural position. The distance between these two images will depend upon the refraction of the atmosphere, and so the instrument may be used to measure that refraction. Professor Luvini proposes that four of his instruments be placed at each observatory, directed to the four cardinal points, and that by their means observations be taken at regular intervals of the condition of atmospheric refraction all around the observatory. He believes that by this method information of coming changes of weather can be obtained earlier than by the means now at the disposal of meteorologists.—18 *A*, *August*, 1876, 558.

IMPROVED MODE OF MOUNTING MICROSCOPIC OBJECTS.

Professor Hamilton L. Smith, of Hobart College, New York, has communicated to the *Journal* of the Microscopical Club a new method of making cells of moderate depth, designed for opaque objects, which is at once simple and easily put in practice. The wall of the cell is made of a brass curtain-ring. Out of a sheet of dark-green or black wax a disk is punched, a trifle larger than the ring, which is fastened to the centre of the slide by melting. The ring is pressed into this, centred, pressed quite through, and the whole finished with Brunswick black. The object is attached to the wax by previously moistening it with turpentine. The cover is dropped just within the ring, its surface being flush with it, and fastened with the black varnish. The soft and delicate appearance of these wax backgrounds gives an exquisite finish to the slide, the absence of obvious cementing material for the object lending an additional charm. Dr. Smith also uses the sheet wax for cells, cutting rings out of it of any desired color, and attaching these both to the slide and cover by slight fusion. The rings are prepared by means of a specially devised press, consisting of a plunger the size of the hole, a centring and a supporting plate. Disks of the sheet wax are dropped in and the hole made in them, the plunger being wetted to prevent adherence.

CURIOUS JAPANESE COMPASS.

Captain J. H. Murray, of the screw-steamship *Scaresbrook*, obtained from a Japanese pilot at Yokohama, in 1874, a remarkable compass, a description of which has been given to the public by Buckland. The compass was taken from the wreck of a junk which had been lost on the island of Vries, a volcanic island at the entrance to Yokohama, the smoke of which, with the snow-capped peak of Fusiyama, indicates the entrance to the harbor. The pilot could give no information about the compass, except that it was found on board the wreck. It is of a circular form, measuring 13.5 inches across, is cast in bronze, and weighs twenty-one pounds. It has a thick rim, in which two ordinary compasses are set, one on each side. The centre of this remarkable plate-like looking object is considerably raised from the surface, and is covered with a number of raised spots or stars of various sizes, each more or less connected by lines with its neighbors. The shapes of these star-like objects are remarkable; in the centre there are five which are larger than the rest. Then there is another group very like a net; another group represents almost a complete circle of these stars; another represents a Y, with the arms closed together; another a Y with the arms extended. Altogether there are no less than two or three hundred of these elevated spots of different sizes. Running throughout the whole series are several lines radiating from a circle drawn around the centre. The brass rim on which the compasses are set is divided into 360 degrees, the same as in an English compass. At every thirty degrees there is a Japanese character. Neither Captain Murray nor any one to whom he has shown this curiosity at home or abroad has any idea whatever of the meaning of the star-like bodies in the centre, or for what purpose the Japanese used them; but it is quite certain that they must have been of some use to them. It is most interesting that these rude characters should be united in the same instrument with the 360 degrees of modern civilization. The casting of the instrument is marvelous.—2 *A*, 1876.

CLAMOND'S THERMO-ELECTRIC BATTERY.

The latest form of the Clamond battery consists of an alloy of two parts of antimony and one of zinc as the negative metal, and ordinary tinned sheet-iron as the positive element, the current at the heated junction flowing from the iron to the alloy. This alloy is cast in the form of a flat bar, broader in the middle than at the ends, and measuring from two inches to two and three-quarter inches in length, by three eighths to one inch in thickness. The sheet-iron, properly stamped out, is placed in a mould into which the melted alloy is poured; before the alloy has cooled the mould is opened and the bars are removed. The alloy melts at 500° Fahr., and expands considerably on cooling. It improves on recasting, but is always very brittle. The bars are arranged radially around a temporary brass cylinder, a thin slip of mica being inserted between the iron and the alloy to prevent contact except at the point of junction. Eight or ten of these bars form a ring, and the several rings are placed one above another, insulated from each other by a circle of asbestus. The inner ends of the bars are heated by a Bunsen burner, the flame issuing in small jets in the annular space between the burner and the bars. The consumption of gas is said to be one cubic foot for each volt of tension per hour. The electromotive force of this combination is such that twenty elements are about equal to one Daniell cell—about one volt. The following table, given on the authority of Latimer Clark, gives the constants of these batteries as sold in London:

Coupled.	Size.	Electromotive force.	Internal resistance.	Consumption of gas—cub. ft.
Tension	40 bars.	2 volts.	1 ohms.	..
“	60 “	3 “	1.5 “	3
“	120 “	6 “	3 “	5
“	150 “	7 “	3.75 “	6
“	240 “	12 “	6 “	9
“	380 “	19 “	6.75 “	23
“	680 “	34 “	12.25 “	37
Quantity	50 “	2.5 “	0.25 “	6
“	60 “	3 “	0.6 “	6
“	100 “	5 “	1 “	9
“	200 “	10 “	2 “	23
“	400 “	20 “	4 “	37

When hot, the resistance of the batteries rises about 25 per cent. The smallest of the above piles costs about $15, the largest about $150. A battery of 375 pairs—the internal resistance of which was 4.5 ohms, and the electromotive force 14.6 volts—deposited 180 grains of copper per hour. The electric light which they give is powerful and constant; but it requires a large number of elements.—*Telegraphic Journal*, 1876.

THE GRAMME LIGHT IN RAILROAD DEPOTS.

Sartiaux has communicated to the French Academy the results of his experiments on the practical use of the electric light of the Gramme machine in illumination, undertaken at the request of the Compagnie du Nord, their stations being used for the purpose. The machines selected for the trials were those rated at 50, 100, and 150 Carcel burners respectively, equivalent to 350, 700, and 1050 candles. The experiments were made in the baggage-room and in the station itself; the former having an area of about 16,000 square feet and a volume of about 670,000 cubic feet, the latter an area of nearly 120,000, and a volume of 10,500,000 feet. The force used was derived from both steam and gas motors, the power being measured with a Prony brake. The Serrin lamp was employed. The results obtained are tabulated as follows:

			Machine 1.	Machine 2.	Machine 3.
Revolutions per minute........................			1650	800	800
Power required to insure a steady light...	carbons, 6 millimeters sq.		2.2 h. p.	2.4 h. p.	2.5 h. p.
	carbons, 9 millimeters sq.		" "	2.6 "	2.7 "
Consumption of carbon and waste.........	carbon, 7 mm...	pos. pole,	" "	0.090 meter.	0.13 meter.
		neg. pole,	" "	0.045 "	
	carbon, 9 mm...	pos. pole,	" "	0.060 "	0.09 "
		neg. pole,	" "	0.030 "	
Distance at which reading was easy........			25 meters.	40 to 45 mtrs.	45 to 58 mtrs.

As M. Tresca showed, the force necessary to produce a light, say of 700 candles, increases rapidly as the total light diminishes. The light being 12,950, 2100, 1050, 700, and 350 candles, the force required is 0.415, 0.920, 1.7, 2.4, and 4.4 horse-powers respectively per 700 candle-lights. Moreover, it will be observed that a little more force is needed to get the light from carbons nine millimeters square than from those which are seven. Calculating the expense of this light as compared with gas, Sartiaux finds that a gas-light of 700 candles requires a consumption of 15.75 cubic meters of gas per hour, which, at the price of 0.3 franc per cubic meter, would cost 5.7 francs ($1.14). The electric light of the same power requires 2.7 horse-power, which, at 0.09 franc per hour, is 0.24 franc. Add to this 0.09 for the carbons, 0.45 for engineer, 0.20 for interest, etc., the total expense is 0.98 franc (nearly 20 cents); being between a fifth and a sixth of the expense of gas. Moreover, the greater extent of surface illuminated increases this difference exceedingly; since to give the same illumination with gas would certainly require at least twenty-five additional burners. To avoid the glare, the light was inclosed in a globe of ground glass.—*Revue Industrielle*, VII., *May*, 1876, 169.

MAGNETISM OF COBALT AND NICKEL.

It has long been known that a bar of iron when magnetized becomes appreciably elongated. Barrett has recently sought to discover whether cobalt and nickel are similarly affected. With cobalt, a slight lengthening may be perceived; but in the case of nickel a contraction, about equal to the expansion of iron, takes place. The bar of nickel used was about two feet long.—1 *A*, *June* 30.

D. CHEMISTRY AND METALLURGY.

CHEMICAL ACTION OF SOLAR RAYS.

Henry E. Roscoe states that although his method of measuring the varying intensity of the chemically active rays as affecting chloride of silver paper has been the means of pointing out many important facts, yet it has not been introduced as a regular portion of the work of meteorological observatories; until which is done we can not hope to obtain any thing like a complete knowledge of the laws of distribution of the chemical rays over the earth's surface. This neglect of Roscoe's method is, in part at least, due to the labor of observing. He has, therefore, advised a modification of the instrument described by him in 1865, and as thus modified the constant sensitive paper is exposed to the action of total daylight at given intervals, say at every hour during the day, by a self-acting arrangement for accurately noting the times. These hourly records are then read off in the evening by the observer. Many mechanical difficulties have been overcome through the skill of Mr. Jordan, of Manchester, and the instruments, as described by Roscoe in the last volume of the "Transactions of the Royal Society of London," are said to give complete satisfaction. In order to read off the intensities of recorded photographic images, a standard series of graduated tints is provided. Special directions are given for the preparation of the sensitive paper. The correction due to the reflection and absorption of the glass cover is also investigated; and the comparison of observations made by hand, and by the self-recording instrument, over twenty days with the two methods, closely agree.—*Philosophical Transactions*, *London*, 1875, 655.

OCCLUDED HYDROGEN IN SO-CALLED EXPLOSIVE ANTIMONY.

The presence of a considerable amount of chloride of antimony was demonstrated several years ago, by Professor Böttger, in the so-called explosive antimony formed on the negative pole, consisting of fine platinum wires, the positive one being of massive antimony, when the current of a single

Bunsen element is passed, for three or four days, through officinal solution of terchloride of antimony, with a resistance of about eight hundred feet of copper wire in the circuit. He has recently also detected occluded hydrogen in it, possessing identical reducing properties with the hydrogen absorbed by palladium. Thus, if the platinum wires, covered with recently deposited explosive antimony, are placed in a very dilute aqueous solution of ferricyanide of potassium, the partial conversion of the latter into ferrocyanide will be evident in the course of ten or fifteen minutes. Pure antimony, perfectly free from arsenic, will not produce such a result. Since the liquid employed is a hydrochloric-acid solution, the liberation of gaseous hydrogen at the negative pole, with the antimony, by decomposition of the acid, might be expected, but not the slightest trace of it could be detected, while, on the other hand, the presence of chlorine at the negative pole, in combination with antimony, without the evolution of hydrogen, is so remarkable that it seems desirable to test other metallic chlorides thus electrolytically.—15 *C*, XXII., 1875, 337.

AMERICAN BROMINE.

The increased demand for bromine, after the introduction of potassic bromide into medicine in 1866, led to its preparation from the mother liquor at the different salt-works of Pennsylvania, and subsequently at those of Ohio and West Virginia. The method employed is the usual one with binoxide of manganese and sulphuric acid. From 1867 to 1870 the production increased from 11,000 pounds to 194,000 pounds. Up to 1870 all was consumed in the United States, but since then it has been exported. The price, however, has been so depressed by excessive production that no new works for its preparation are being established. —18 *C, February* 9, 1876, 95.

DETERMINATION OF OZONE IN THE AIR.

The determination of the quantity of ozone in the air has not yet been achieved by any convenient method, since the tint of the ordinary ozone test-papers is determined by the velocity of the wind. It was supposed by Von Pettenkofer that the absence of the ozone reaction in the atmosphere of closed dwelling-rooms was due to the slight circulation in the air. This subject has, however, been fully investigated by Wolffhugel, who finds that, while a given quantity of fresh air yields a very visible ozone reaction, yet ten or twelve times that quantity taken from the interior of dwellings produces no effect, even when the rooms are unused, having previously been well aired. Wolffhugel has also shown that there is a great absence of ozone in the air near the ground.—7 *C*, 11, 122.

DECOMPOSITION OF WATER.

Gladstone and Tribe find that when aluminum foil and iodine are placed together in water, hydrogen is copiously evolved. The same phenomenon takes place if aluminic iodide be substituted for iodine, its formation really being the first part of the reaction just described. Aluminic bromide or chloride acts in much the same manner, the aluminum used being almost completely oxidized. The same experimenters sought to determine whether zinc or iron, heated with solutions of their respective iodides, would yield hydrogen, and obtained only negative results. These metals, however, with aluminic iodide in water, produced readily a copious evolution of the gas. Aluminum alone decomposes water, according to Deville, only at a white heat. But Gladstone and Tribe, by simply coating aluminum foil either with copper or platinum, procured couples which effected the decomposition quite easily at the low temperature of 100° Centigrade.—21 *A*, 822, *September*, 1875.

DECOMPOSITION OF WATER BY PLATINUM.

Deville and Debray find that when a mixture of potassium cyanide and spongy platinum is heated together in the neighborhood of a little water, at about 500° or 600°, a vacuum having first been established, great quantities of hydrogen are evolved, and the well-known platino-cyanide of potassium is formed. The hydrogen is not pure, but contains small quantities of ammonia, and from four and a half to twelve per cent. of carbonic oxide.—6 *B*, *January* 24.

CRYOHYDRATES.

About a year ago Professor Guthrie described under the above name a set of hydrates which exist only at very low temperatures. Whenever a crystalline salt is dissolved in water and the solution frozen, solidification takes place *below* the Centigrade zero, and a definite compound of the water with the salt is formed. And whenever any crystalline salt is mixed with ice or snow, the same compound is formed, and a fall of temperature ensues. Hence with every crystalline salt a freezing mixture may be prepared. Guthrie now extends his observations to colloid bodies, and shows that they act very differently from the crystalloids. Thus from a solution of gum, gelatin, or albumen all the water separates as ice at 0° Centigrade, and no cryohydrate is produced. This new distinction between crystalloids and colloids seems to be of the very highest importance.—1 *A*, *June* 30.

NATURAL DEVELOPMENT OF SULPHURETTED HYDROGEN.

Faulquier narrates a curious phenomenon which took place during the summer of 1875 at Palavas, near Montpellier. In the vicinity of this place are extensive salt marshes, which, in consequence of persistent north winds, have become almost dried up. The accompanying heat of the season has produced a rapid decomposition of the organic matter in the soil, which has been accompanied by a development of sulphuretted hydrogen. The existence of this gas has been very palpable to the senses, and has also produced an unexpected influence upon the residences near by, the painted surfaces of the houses having first turned brown, and finally almost entirely black, while the paint even in the interior of the houses has become much altered. All silver and silvered objects have also become blackened by the same influences. Another effect is that of loosening and crumbling away of the plaster between the joints of the building-stones, which Faulquier attributes not to the sulphuretted hydrogen, but to the saline particles contained in the atmosphere.—1 *B*, *September* 5, 346.

AMMONIA IN SULPHURIC ACID.

Professor F. H. Storer finds that ammonia in traces is an invariable contaminant of sulphuric acid. Nine samples of acid were examined from different manufactories, seven being obtained direct from the makers. These were kept previous to examination in tightly stoppered bottles, and in every case the portion tested was taken from the middle of the bottle containing it. The same impurity, ammonia, was also found in a very large number of other chemicals in the preparation of which sulphuric acid is employed. Professor Storer thinks that the ammonia may get into the acid, partly from the air, partly from the water employed, partly from a reduction of the nitric acid used in oxidizing the sulphur dioxide formed in the first stage of the sulphuric manufacture. In fact, he finds by direct experiment that whenever dilute nitric acid is made to act either upon lead or sulphur (as in the leaden chambers of sulphuric-acid works) traces of ammonia are produced.—4 *D*, *December*, 1875.

AMMONIUM NITRITE.

This extraordinary substance has been reinvestigated by Berthelot, who obtained it by double decomposition from barium nitrite and ammonium sulphate. The filtered solution, evaporated over quicklime in vacuo, yields crystals of the substance desired. It is also formed by the simultaneous reaction upon each other of nitrogen tetroxide, dry ammonia, and oxygen. It forms a white, crystalline, deliquescent salt, having peculiar elastic properties. It decomposes slowly at ordinary temperatures; at 60° to 70° Centigrade it explodes violently; under a severe blow it detonates. In solution the salt, anomalously, decomposes more rapidly than when dry; heated, torrents of nitrogen are evolved. It seems to be one of the least stable bodies known.—*Annales de Chimie et de Physique.*

ACTION OF NITRIC ACID ON METALS.

The subject indicated by the heading of this paragraph has recently been studied by Mr. J. J. Acworth, who explains some points which have often led to confusing uncertainties. Thus nitric acid, acting in the cold on copper, should yield nearly pure nitric oxide, but does not always. Acworth finds that as cupric nitrate accumulates in the solution, nitrous oxide begins to be formed; and that when the above-named salt becomes sufficiently abundant the latter gas is given off almost alone. If ammonic nitrate be added to the nitric acid during its action on copper, the gases evolved consist chiefly of nitrogen with nitrous oxide, and smaller quantities of nitric oxide. The acid, acting upon zinc or mercury in the presence of ammonic nitrate, yields little gas but nitrogen; with silver, nitric, but no nitrous oxide is also formed.—21 *A*, *September*, 1875.

CONSTITUTION OF PHOSPHORUS OXYCHLORIDE.

The constitution of phosphorus oxychloride has long been a matter of discussion. Ira Remsen now shows that the compound may be formed by the direct action of ozone upon the trichloride. This fact strengthens the view which regards phosphorus as pentatomic, and obliges us to look upon the atom of oxygen in the oxychloride as directly satisfying the two bonds of affinity left free in the trichloride.—4 *D*, *July*.

DISCOVERY OF VANADIC ACID IN MAGNETIC IRON.

Dr. Isidor Walz communicated to the American Chemical Society, May 4th, that he had discovered 0.3 to 0.4 per cent. of vanadic acid in magnetic iron ores from the Church Mine, New Jersey. Apart from the scientific interest attaching to the rich occurrence of that rare metal on our soil, this discovery may lead to important practical results, as the salts of vanadium have recently begun to play an important *rôle* in the preparation of aniline black, indelible marking-ink, etc., and the supply has hitherto come from much poorer sources than the one now disclosed.

CARBON FROM THE ROOF OF A GAS-RETORT.

Mr. A. McDougall exhibited before the Manchester Literary and Philosophical Society a specimen of carbon obtained from the roof of a gas-retort, resembling graphite in its almost metallic lustre. It was undoubtedly produced by the decomposition of the hydrocarbon gases in the intense heat of the retort; and it is suggested that its formation may throw some light on that of graphite, as that substance is always associated with rocks that have been subjected to igneous action.—18 *A*, *April* 9, 1875, 89.

LIQUID CARBON DIOXIDE IN MINERAL CAVITIES.

W. Noel Hartley, examining the liquid which occasionally occurs in the cavities of quartz, has corroborated the conclusions of Davy and Brewster with regard to its being liquefied carbon dioxide. He noted that at the temperature of about 31° Centigrade the liquid in such a cavity disappeared entirely, to return upon cooling. Dr. Andrews gives 30.92° Centigrade as the critical temperature of carbon dioxide, so that there can no longer be any doubt concerning the nature of the liquid under examination.—1 *A, March* 26.

CARBON MONOSULPHIDE.

Sidot finds that when carbon disulphide, inclosed in hermetically sealed tubes, is exposed for about two months to the action of sunlight, brown flakes of the new monosulphide, CS, are deposited. This substance, dried and purified, is a chestnut-brown, tasteless, odorless powder of 1.66 specific gravity. It is insoluble in water, alcohol, turpentine, or benzol; boiling ether or carbon disulphide dissolves traces of it. Hot nitric acid dissolves the monosulphide to a red liquid; but chlorohydric acid is without action upon it. A boiling solution of caustic potash takes it up freely, forming a blackish brown liquid, from which acids reprecipitate the substance. At 200° Centigrade the new sulphide decomposes, sulphur distilling off, and carbon remaining behind.—18 *C*, 1875, *September* 29.

A NEW CLASS OF CYANIDES.

Gaston Bong, studying potassium ferrocyanide and some of its derivatives, has obtained a remarkable new double salt. It is formed by treating a mixture of the common yellow prussiate and potassium chlorate with sulphuric acid until a persistent blue color is produced. The resulting mass is heated gently, extracted with water, neutralized with sodium carbonate, boiled and filtered. This solution, by careful crystallization in vacuo, yields black crystals, which, readily soluble in water, give it an intense violet color. The compound may be regarded as the type of an entirely new class of double cyanides, and its relation to well-known ferro- and ferricyanides may be indicated by formulæ:

Potassium ferrocyanide	K_2FeCy_3
Potassium ferricyanide	$K_3Fe_2Cy_6$
New compound	$K_4Fe_4Cy_{12}$

Thus, in this series, every added potassium atom needs a doubling of all the other atoms in the molecule. The new salt is a powerful oxidizing agent, and produces greenish precipitates with metallic solutions.—*Bull. Soc. Chimique*, 1875, *October* 5.

IMPROVEMENT IN THE AMMONIA-SODA PROCESS.

The following improvement in the ammonia process for the manufacture of soda has been patented in England. The solution of chloride of ammonium formed is mixed with carbonate of magnesia and distilled, and the carbonate of ammonia, which passes over, is again used in the manufacture of soda. The solution of chloride of magnesium remaining, which also contains some chloride of sodium, originally present with the chloride of ammonium, is concentrated, and the chloride of sodium removed from time to time as it crystallizes out. What remains is then calcined with the formation of hydrochloric acid and magnesia. The latter is reconverted into carbonate by the gaseous products of combustion from the furnace. The separation of the chloride of sodium before the calcining is important, as otherwise the chloride of magnesium will not be decomposed by heat alone. A partial decomposition of the chloride of magnesium, however, is said to be more favorable to the conversion into carbonate than complete decomposition.—5 *C*, XXXVIII., 1875, 303.

MANUFACTURE OF SODA FROM SEA-WEED.

Herland, in *Comptes Rendus*, calls attention to some defects in the treatment of sea-weed for the manufacture of soda, and makes some suggestions for an improvement of the process. He remarks that in the ordinary method the weeds destined to be calcined are dried on the shore in the open air, involving decomposition and a loss of salts by moisture, and that the process of incineration is itself defective. The method by which he proposes to remedy the difficulty is as follows: Place the fresh weed in baskets of iron wire, moved by a turning crane, and steeped in a series of vats containing about fifty kilogrammes of good quicklime per cubic meter, and so placed that it can pass in succession from vat to vat until it is exhausted of its useful salts. The time of steeping in each vat is from forty to sixty minutes. The successive saturated lyes are to be reduced to dryness and treated with carbonate of potash. This will yield a soda very rich in soluble salts and alkaline iodides. While the incineration gives but fifteen per cent. of potash and one per cent. of iodide, the new process yields forty to fifty per cent. of potash, and sometimes six per cent. of iodide. The residual weeds are applicable to agricultural purposes.—1 *A*, *July* 21, 1876, 32.

ATOMIC WEIGHT OF CERIUM.

Bührig, by means of a series of careful combustions of cerium oxalate, has very accurately redetermined the atomic weight of the metal. This, based upon the values given by Stas for carbon and oxygen, he finds to be 94.1782. This value is the mean of results obtained in fifteen experiments. —*Journal für prakt. Chemie*, XII., 209.

THE CERIUM METALS.

The rare metals cerium, lanthanum, and didymium have at last had their atomic weights definitely fixed by Hillebrand. He determined the specific heat of each metal by means of Bunsen's ice calorimeter, getting the following values: Cerium, 0.04479; lanthanum, 0.04485; didymium, 0.04563. These figures, considered with reference to Dulong and Petit's law, correspond respectively to the atomic weights 138, 139, and 144.78. These observations prove that the lower oxides of these metals are really sesquioxides, and the higher oxides, dioxides. Until lately the atomic weights of this group have been rated at only two thirds of the above values.—*Poggendorff's Annalen*, 1876, No. 5.

CERIUM, LANTHANUM, AND DIDYMIUM.

These rare metals have recently been isolated in quantity by Drs. Hillebrand and Norton, students under Bunsen at Heidelberg. Cerium outwardly resembles iron, is very ductile and malleable, and tarnishes readily. In hardness it about equals silver, and its melting-point is at a full red heat. Heated in the air it kindles very easily, at a lower temperature even than magnesium, burning with great brilliancy. Upon shaving a cerium wire with a knife the thin fragments of metal ignite as they are cast off, while with an ordinary fire-steel sparks can be struck from it as from a flint. Didymium and lanthanum resemble cerium closely, but are less inflammable, and do not tarnish so easily. The specific gravities are as follows: Cerium, 6.628 to 6.728; lanthanum, 6.049 to 6.163; didymium, 6.544. In their electrical relations the three metals lie between magnesium and zinc; they are electro-positive to the latter, electro-negative to the former.—*Poggendorff's Annalen, March* 25, 1875.

EXPERIMENTS ON STEEL.

MM. Trève and Durassier have communicated to the French Academy the following results of their investigations into the relation existing between the chemical and physical properties of steel. They prepared fifteen bars of steel, divided into five series of three bars, each series being of a different degree of carburation, and each tempered in a different manner. These bars were then magnetized to saturation, and their magnetic force determined by the method of deflection. The bar containing 0.95 per cent. of carbon, and tempered with cold water, caused the maximum of deflection, represented by 47. The bar containing the same amount of carbon, but tempered with oil at 10° Centigrade (50° Fahr.), gave 43. That the magnetic capacity of steel is influenced by the nature of the liquid used for tempering seems therefore to be manifest. The bar containing 0.25 per cent. of carbon gave a deflection represented by 13, showing how decided is the influence which it exerts. In preparing diagrams of variations for the different series of bars, the influence of the percentage of carbon and of the tempering liquid became manifest. It was remarked, however, that at the top of the scale in carbon, the nature of the tempering liquid no longer exerted a very marked influence. The study of these diagrams brought to light, likewise, the noteworthy fact that a remarkable similarity existed between the magnetic curves and the curves of elasticity of the bars. The investigators assert from their experimental trials that carbon gives elasticity to the steel, and at the same time enhances its capacity for magnetism.—3 *A*, V., 556.

FLUENCE OF FOREIGN INGREDIENTS UPON THE PHYSICAL PROPERTIES OF STEEL.

perience that has of late been gained in the pro-
hosphuretted steel may be characterized as a

triumph which promises the most substantial results for this important branch of metallurgical industry. It has been demonstrated that the peculiar properties of steel are not governed absolutely by the presence of a certain percentage of one or two substances, like phosphorus or carbon, but that these properties may be secured and modified at pleasure by judiciously controlling the relative proportions of a number of foreign ingredients introduced into the metal. The progress that has been made in this direction has been intelligently summarized by *The Engineering and Mining Journal:* "By securing the proper relative proportions of carbon, phosphorus, silicon, and manganese, a steel of great softness and strength can be obtained, while the same percentage of phosphorus in an ordinary steel would have indicated very different properties (which means, in other words, that it would have been quite worthless). There can no longer be much doubt that manganese exerts upon steel a body-giving, toughening influence, as well as a neutralizing effect upon the hardening or cold-shortening due to phosphorus. Though these properties of manganese have been suspected for some time, the mutual dependence, and to a certain extent interchangeability, of carbon and phosphorus were not fully appreciated until M. Tessié du Motay succeeded in producing with ferro-manganese a good steel rail, containing about 0.12 per cent. of carbon, 0.25 of phosphorus, and 0.75 of manganese." In the light of the recent investigations, therefore, phosphorus is no longer entitled to the evil distinction of being, as a well-known metallurgist has expressed it, "the very scourge and pestilence of the steel-maker," and the time is possibly not far away when many rich deposits of ore now esteemed to be worthless will find ready utilization.

GALLIUM.

M. Boisbaudran states that in his first discovery of gallium he did not possess more than one hundredth of a milligramme of the metal dissolved in a minute drop of liquid. Lately, with a larger supply of material, he has determined some of its characteristics. The spectrum is exceedingly brilliant, giving with a gas flame the line 417; in a spark spectrum line 403.1 also appears. The metal can be deposited electrolytically upon copper, forming a hard layer, difficult to burnish and rather whiter than platinum. It was originally found in a blende from the Pyrenees, but has since been detected in blendes from various other sources, so that the discoverer thinks it may be quite widely diffused. Its most important chemical feature is that it forms apparently a true alum, thus belonging with indium and aluminium in classification. This fact is particularly interesting when considered in connection with a brief article by Mendelejeff. This author some few years ago, in his paper upon the "periodic law," ventured upon theoretical grounds to predict the existence of several then unknown metals. In all probability gallium is one of these, and will fill a gap which Mendelejeff pointed out in the aluminium group. The verification of such a prophecy might well afford a parallel to the discovery of the planet Neptune.—1 *A.*

GALLIUM.

M. Boisbaudran has succeeded in isolating about half a gramme of this new metal, and has redetermined some of its leading characteristics. In the fused state it is of a fine silver white color; but in crystallizing it assumes a pronounced bluish tint, and loses considerably in brilliancy. The metal, by cooling from fusion, may be obtained in isolated crystals, which are octahedral. The melting-point, previously put at 29.5° Centigrade, is now, as a mean of six closely agreeing measurements, fixed at 30.15°.

Great interest attaches to the specific gravity of gallium. A few months ago it was determined to be 4.7 at 15° Centigrade, the determination being made with a specimen of metal weighing only six centigrammes. But, calculated upon the basis of Mendelejeff's law—the law by which the existence of gallium was predicted—the value should have been 5.9. Two new determinations, now published by Boisbaudran, give 5.935 and 5.956. This agreement with theory is very close and very striking.—6 *B*, LXXXIII., 611, *September* 18.

DESILVERIZATION OF ARGENTIFEROUS ZINC.

The desilverization process introduced by Parkes in 1850, but subsequently neglected in consequence of the difficulty of recovering the metallic zinc so as to be re-employed in a continuous process, has been again brought into operation at Tarnowitz, in Silesia. The argentiferous zinc crust is now allowed to cool in an iron basin, then placed in the liquating furnace, where, by gentle heating, with full access of air, it is deprived of the greater part of its lead. By this means the zinc is thoroughly oxidized and converted into the so-called zinc dust, which is then distilled between layers of powdered coke, with the production of metallic zinc, free from silver, on the one hand, together with a residue containing the whole of the silver, along with any lead remaining in the zinc dust. —18 *A*, *April* 9, 1875, 89.

ON THE FUSIBILITY, ETC., OF ALLOYS OF SILVER AND COPPER.

Mr. Roberts, chemist to the English Mint, has communicated to the Royal Society the result of a detailed elaborate investigation into the liquidation, fusibility, and density of certain alloys of silver and copper. The melting-point of the several alloys experimented upon by him varied from 840° Centigrade to 1330° Centigrade, the most fusible alloys being those that contain from sixty to seventy per cent. of silver; and the fusibilities vary very much as to the electric conductivities. The density of pure silver, when fluid, is 9.46; its density when solid is 10.57. This alloy, therefore, on becoming fluid, expands at nearly double the rate that it expands when at ordinary temperatures. Mr. Roberts has also succeeded in obtaining excellent results in the electro-deposition of iron, for which purpose he employs a solution of the double sulphate of iron and magnesia. The iron thus obtained possesses a higher electric conductivity than any commercial iron, and occludes thirteen times its volume of hydrogen. The tube of the metal, which was a vacuum tried at the ordinary temperature, allowed hydrogen to pass through it freely at a dull red heat.

A NEW TEST FOR GOLD.

M. Sergius Kern, of St. Petersburg, in studying the behavior of certain double salts of gold, made the observation that the sulpho-cyanide of potassium was a most sensitive reagent of this metal, which, as experiment proved, would indicate the presence of less than the 0.001 of a gramme of gold. He proposes the following procedure: The gold of the sample under analysis is first separated in the usual manner from foreign metals, and next converted by means of sodium chloride into sodio-gold chloride ($NaAuCl_4$); the solution is then concentrated by evaporation. In order to detect the presence of gold, an aqueous solution of potassium sulpho-cyanide (KCyS) is employed, which should contain, for one part of the salt, about fifteen to twenty parts of water. About six grammes of this solution are poured into a test-tube, and some drops of the suspected gold solution, treated in the manner above described, are added. If gold is present, a red-orange turbidity is at once obtained, which soon falls in the form of a precipitate. On gently heating the contents of the test-tube, the precipitate dissolves, and the solution becomes colorless. This reaction is said to be so delicate that one drop of a solution of the sodio-gold chloride (one gramme of the salt in forty grammes of water) affords a decided reaction. The reaction indicates, according to the observer, the formation of a double sulpho-cyanide. —1 *A*, XXXII., 171.

PURE PLATINUM AND IRIDIUM.

Deville and Debray, obtaining pure platinum and iridium in quantity, have found for these metals rather higher densities than are commonly ascribed to them. The platinum has a specific gravity of 21.5, while that of iridium is 22.421. An alloy containing eighty-five per cent. of platinum to fifteen of iridium, with density 21.618, was found to be very ductile and malleable, and yet quite rigid. Probably it would be useful in the arts. An alloy containing only 66.67 per cent. of platinum, on the other hand, was not malleable.—*Supplement to* 7 *A*, *December*, 1875.

OSMIUM.

According to Deville and Debray, osmium is the heaviest substance known, having a specific gravity of 22.477. They have prepared the metal in a crystalline form by passing the vapor of osmic acid over red-hot charcoal. The crystals apparently belong to the first or regular system, and are hard enough to scratch glass. The color is grayish-blue, becoming even violet when the light is reflected several times upon the surface of the metal.—6 *B*, *May* 8, 1876.

CONVERSION OF BRUCINE INTO STRYCHNINE.

Sonnenschein has shown that brucine may be converted into strychnine by the action of nitric acid, and calls attention to the fact that this discovery may be of practical interest in toxicological investigations, since brucine might be converted into strychnine in course of the examination.—35 *C*, 1875, IV., 212.

OLEANDRINE.

It has long been known that oleander leaves contain an active poison, which was first examined by Lukowski in 1861. This body, oleandrine, has lately been reinvestigated by Bettelli, who obtained it in an imperfectly crystalline condition. It is pale yellow, soluble in water, alcohol, ether, chloroform, fusel-oil, and olive-oil. At 56° C. it softens, becomes a greenish liquid at about 70°, and at 170° it undergoes partial decomposition. Bettelli also succeeded in forming the chlorhydrate of the alkaloid.—35 *C*, *September* 27.

BISULPHIDE OF CARBON AS AN ANTISEPTIC.

Hugo Schiff calls attention to the remarkable antiseptic properties of carbon disulphide. A dissected frog, which had served for physiological experiments, was sealed up in a glass vessel, with a few cubic centimeters of the antiseptic, as long ago as 1869; the specimen as yet shows no trace of putrefaction. A similar trial with the entrails of poultry, and another with a small lizard, have resulted likewise. Two hundred grammes of beef, treated with bisulphide, remained for months unaltered; and then, after cooking, was readily eaten by a dog.—35 *C*, IX., 828.

MANUFACTURE OF CARBOLIC ACID.

The following process for separating carbolic acid from the cresylic and other liquid tar acids was recently patented by Lowe and Gill in England. The partially or wholly hydrated mixtures of tar acids are submitted for a sufficiently prolonged time to a temperature varying between 15° and 56° Fahr. The carbolic acid crystals thus formed are separated from the mother liquors containing the liquid tar acid and a residue of carbolic acid dissolved in them. Complete purification of the carbolic-acid crystals thus obtained is effected by recrystallization, either by partial fusion or solution in water, with subsequent refrigeration. Carbolic acid of high degrees of purity is obtained by dehydrating these carbolic-acid crystals.—*Practical Magazine*, *Dec.*, 1874, 437.

DETECTING ADULTERATIONS IN COFFEE.

Wittstein, in a paper published in "Dingler's Polytechnic Journal," gives a detailed method for testing coffee, which is treated in a great variety of ways for the purpose of imparting greater strength or weight, a better color, or some other desired quality. He remarks that roasting, and still more grinding, coffee renders it almost impossible to apply the necessary tests. The principal vegetable substances used in adulterating coffee are chicory, beet-root, carrot, figs, corn, malt, etc. A simple method of testing coffee for a mixture of chicory is to shake it with water; if pure it remains floating for an hour together, whereas chicory sinks. An infusion of burned chicory, diluted with much water and treated with potassium bichromate, undergoes no visible change; but coffee assumes a deep brown tint, causing a resemblance to porter. This is only observed, however, where the substance is either entirely coffee or entirely chicory. To detect a mixture of the two, the decoction is diluted with eight times its bulk of water, filtered, and the dilution increased to twelve parts. If the decoction contains pure coffee, on adding to thirty drops of it two drops of concentrated hydrochloric acid, boiling for a few seconds, then adding fifteen drops of a solution of one part of potassium ferrocyanide in eight parts of water, and boiling as before, the solution becomes first green, then dark green. Six drops of potash are next added, and the whole is boiled for two minutes, the solution becoming first brown and then clear pale yellow, with a slight dirty-yellow precipitate. With chicory alone, the solution finally remains brown and turbid, and after long standing a precipitate falls, the supernatant fluid retaining its brown color. With a mixture of twenty-four drops of coffee and six of the chicory decoction, a final brown turbid solution is obtained. A decoction of coffee of average strength contains one per cent., and of great strength barely two per cent., of the dry soluble matter. The evaporation residue consists of a deep brown, shining, varnish-like mass, feeling quite dry to the touch after two days. If the ordinary substitutes are present, however, this residue becomes sticky after one or two hours' standing, and quite damp in twenty-four hours.

ON THE GASES INCLOSED IN COAL.

An examination of the gaseous substances contained in coal, and also of the gases which are evolved from fissures in coal-mines, has been made by Thomas. The coals which he examined were of three sorts: the bituminous or house coals, the semi-bituminous or steam coals, and the anthracite coals. The samples examined all came from the South Wales coal-basin. In obtaining the gas from the coal, slices were first sawn from the middle of large cubical blocks, and a strip cut from the centre of each of these six or eight inches long, and five eighths of an inch square. This was then placed in a hard glass tube, connected with a mercury pump, and exhausted. Very little gas, however, was obtained in this way—only two or three cubic centimeters in 100 grammes of coal. On placing the tube in boiling water, the exhaustion being continued, gas was freely evolved. When it ceased, the temperature was raised to 200° and even 300° Centigrade, whereby additional quantities of gas were obtained. On analyzing the gas, it was found to be composed of marsh gas, carbon dioxide, nitrogen, and oxygen. The bituminous coals give the minimum amount of gas, but the quantity of carbon dioxide contained in it is large. Steam coals come next, as much as eighty-seven per cent. of the gas obtained from them being methyl hydride, or marsh gas. Anthracite coals give more gas than the others, one specimen giving 600 cubic centimeters of gas from 100 grammes of coal when heated to 100°. But at 200°, 1000 c. c. were given off, and at 300°, 1875 c. c. In composition, the gas from anthracite closely resembles that from steam coal. The examination of the gas collected from fissures in the mine, as well as that obtained by boring the blocks of coal, was almost pure marsh gas, the amount present rising sometimes even to 97.65 per cent.—21 *A*, II., xiii., *September*, 1875.

SCHÖNBEIN'S TEST FOR NITRATES.

Storer has explained at length the reaction proposed by Schönbein for the detection of minute traces of nitrates. Two modes of applying the test were originally given. In the one, dilute sulphuric acid and iodo-starch paste were added directly to the nitrate solution, and the mixture was stirred with a zinc rod. In the other and better mode, the nitrate was first reduced by means of zinc or cadmium, and then the solution was acidulated with sulphuric acid and the iodo-starch paste added. He finds, contrary to the opinion of Carius, that no objection seems to lie against this test on the score of delicacy; but that it has a fatal defect in the forms in which it is commonly used, in that mere water, entirely free from any nitrates or nitrites, will, on being treated with zinc or cadmium as in the process of testing, react upon iodo-starch as if these compounds were present. This coloration, thus produced, the author shows is due to the hydrogen peroxide which is formed by the action of the metal itself upon the water — a reaction observed by Schönbein himself. Hence, whenever the degree of coloration of the iodo-starch obtained in testing for a nitrate by this method is less intense than the tint obtainable from 0.000187 gramme of potassium nitrate in 50 cubic centimeters of water, it is difficult to decide whether the coloration may not be wholly due to hydrogen peroxide. Having thus shown the defect, the author set himself at work to remedy it, and to devise a modification of the process which, while preserving the delicacy of the test, should yet be easily applied. The very simple plan was adopted of acidulating the solution very slightly, before boiling the nitrate in it, with metallic cadmium. Under these circumstances no hydrogen peroxide is produced, while the reduction of the nitrates goes on quite as well. The only precaution necessary is to prevent the loss of any of the nitrous acid, which is easily accomplished by attaching to the flask a small inverted Liebig condenser during the boiling. In his experiments, 0.0001 gramme of nitrogen pentoxide, placed in the solution as potassium nitrate, in 50 c. c. of water containing two drops of dilute sulphuric acid, gave, after boiling for five minutes, a reaction in less than fifteen minutes. Even 0.00005 gramme gave the reaction in the course of half an hour. Zinc, amalgamated zinc, aluminum, iron, lead, and magnesium were also used as reducing agents, but none of them acted as efficiently as cadmium. No experiments were made with the alkali metals.—4 *D*, III., xii., *September*, 1876, 176.

HYDROCELLULOSE.

In some of the processes in the arts in which woody fibre is used, as in paper-making, for example, the fibre appears to undergo during the process of manufacture a peculiar transformation, by which it is rendered friable. Aimé Girard has investigated the matter, and finds that this change is owing to the assumption of a molecule of water by each molecule of the cellulose, thus producing a new body having the composition $C_{12}H_{22}O_{11}$, to which he gives the name of hydrocellulose. To prepare it some form of purified cellulose, such as carded cotton, is placed in sulphuric acid of 45° Baumé in the cold for twelve hours. It is then well washed, pressed, and dried. After it is dry, its fibrous character is destroyed by pressure; rubbing between the fingers converts it into a white powder. Girard supposes that this substance may be formed in the process of bleaching paper-pulp by chloride of lime; and accounts in this way for the peculiar brittleness of certain papers found in commerce.—6 *B*, LXXXI., *December*, 1875, 1105.

A NEW OXIDE OF SULPHUR.

Weber has investigated the cause of the intense blue color which is developed whenever sulphur is allowed to act upon sulphuric oxide or disulphuric acid, and has shown that it is due to an oxide of sulphur hitherto unknown, which he has succeeded in isolating and examining. To prepare it, carefully dried flowers of sulphur are thrown in small portions at a time into sulphuric oxide containing sulphuric acid. At the instant of contact, the sulphur is converted into dark blue liquid drops which sink to the bottom of the liquid and there solidify. Care should be taken to keep the temperature at 15° Centigrade, since below this point the whole liquid solidifies, and above it the blue body decomposes. After the operation the excess of liquid is poured off, the blue crystalline crusts are drained, and the excess of sulphuric oxide driven off at a temperature not exceeding a blood heat. Bluish-green crusts are thus obtained which are very friable, and which have a structure similar to malachite. They decompose without fusion slowly at ordinary temperatures, more rapidly on heating, evolving sulphurous oxide, and leaving sulphur behind. In a cool place the decomposition is so slow that the substance may readily be weighed for analysis. Moist air decomposes it rapidly, and it hisses when thrown into water. Alcohol and ether also decompose it and set free sulphur. A mean of five closely accordant analyses showed that it contained 57.12 per cent. of sulphur, thus giving it the formula S_2O_3. The author names it sulphur sesquioxide, or dithionic oxide. No compounds of it have yet been made. Selenium gives an analogous compound, having the formula $SeSO_3$. It is dirty green in mass, but is yellow when in powder.—*Poggendorff's Annalen*, CLVI, *December*, 1875, 531.

CORROSION OF PLATINUM STILLS BY SULPHURIC ACID.

Scheurer-Kestner having communicated to Hofmann, in 1862, certain results which he had obtained in the process of concentrating sulphuric acid in platinum stills (which results were published by the latter in his Report on Chemical Industry), and these results having been since that time called in question, the author has examined the facts in the case still more fully, and now publishes a new set of observations. From 1851 to 1861, 4309 tons of sulphuric acid were concentrated to 66° Baumé, in an alembic the body of which weighed 40 kilogrammes. The entire loss of this part of the still during this time was 12,295 grammes, being 2.859 grammes for each ton of acid worked. Perceiving that the cause of this large loss in platinum was the presence of nitrous products, ammonium sulphate was added to the acid in amount just sufficient to destroy them. In 1862, 1843 tons of acid were concentrated in the still, with a loss of 2490 grammes, being only 1.22 grammes of platinum for each ton of acid, a marked decrease. From 1864 to 1875, 17,516 tons (of 1000 kilogrammes each) were concentrated to 66° in a still the body of which weighed 50 kilogrammes. The acid contained sulphurous acid, but no nitrous compounds. The loss of the still was 16,178 grammes, or 0.925 gramme to the ton of acid. It may be assumed, therefore, that to produce an acid of 66° Baumé (containing 94 per cent. of real acid), there is a loss to the still per ton of acid of one gramme when nitrous compounds are absent, and of 2½ to 3 grammes when they are present. If, however, the concentration be carried above 66°, these numbers are much increased. In a still weighing 30 kilogrammes, 180 tons of acid, containing 97 to 98 per cent. of real acid, were produced. The still lost 1092 grammes of platinum, or 6.07 grammes per ton of acid. In producing 47½ tons of acid of 99½ per cent., there was a loss of 8.8 grammes of platinum per ton of acid, and an analysis of the acid showed that it contained 8.38 grammes of platinum to the ton, present in it in solution, thus proving the loss to be a chemical one. To the figures here given for the loss of the body of the retort, about 13 per cent. should be added for the loss of the other parts. The use of a platinum-iridium alloy for the stills prevents to a large extent this action, but the brittleness and consequent fragility of the alloy is a serious objection to it.—*Bull. Soc. Ch.*, II., xxiv., *Dec.*, 1875, 501.

NON-OXIDATION OF CARBONIC OXIDE BY OZONE.

The question of valency among the elements is a fundamental one in chemistry; and while all chemists are agreed that a given atom may form a series of compounds with the same substance, they are divided on the question of the interpretation of this phenomenon. On the one hand, it is claimed that the valence of an atom is fixed and invariable, and consequently all but one of its compounds, and that the highest, must be unsaturated. On the other, it is asserted that the valence is variable, and that by twos, and consequently that in the lower of two compounds formed by an element it is as fully saturated as in the higher. Carbonic oxide, for instance, whose molecule contains one carbon and one oxygen atom, has, according to the former view, two free bonds. But according to the latter it is saturated, though at a lower stage than in carbon dioxide. The weak point in the theory of variable valence is the law of, or the cause for, the variation. The constitution of carbonic oxide being thus in doubt, Remsen and Southworth have sought to throw some light upon it by acting upon it with ozone, a body which is supposed to give up its extra oxygen atom with great readiness. For this purpose they passed the pure monoxide through potassium hydrate and lime-water into a flask. Into the same flask oxygen was passed after treatment with potassium hydrate and lime-water, and also after being ozonized. The interior of the flask was moistened. From the flask a third tube led the products first through lime-water and then over potassium hydrate. But, though the currents of gas were slow and the action was long continued, not a trace of dioxide was formed, even when the experiment was repeated in direct sunlight. This result is the more suprising from the readiness with which carbonic oxide is oxidized by chromic acid solution. The authors propose to study the action of hydrogen peroxide on this substance.—4 *D*, III., xi., *February*, 1876, 136.

ON THE HYDROCARBONS OF COAL GAS.

Berthelot has made a somewhat exhaustive investigation of the hydrocarbons existing in coal gas, the results of which go to confirm his theory of the action of acetylene and hydrogen at high temperatures. In the gas which is supplied to the city of Paris he finds that benzene may be detected very readily in so small a quantity as two or three cubic centimeters by exposing in it a drop of fuming nitric acid. On diluting the drop with water, the peculiar almond odor of nitrobenzene is at once recognized. If fifty liters of the gas be passed through 8 or 10 c. c. of the acid, enough nitrobenzene separates on dilution to weigh; and from the amount thus obtained it appears that this gas contained two or three volumes of benzene vapor in the hundred. More accurately, the amount present is from 3 to 3.5 volumes. Next to marsh gas, therefore, benzene is the principal hydrocarbon in coal gas, and is the substance to which the gas mainly owes its illuminating power. Besides benzene, the gas contains ethylene, propylene, and butylene of the olefine series, and acetylene, allylene, and crotonylene of the acetylene series. These bodies were detected by absorbing them with concentrated sulphuric acid, diluting, and then fractioning. In one million volumes of the Paris gas, the author concludes that there are by this analysis: Benzene in vapor, 30,000 to 35,000 volumes; acetylene, 1000 (about); ethylene, 1000 to 2000; propylene, 2.5; allylene, 8; butylene and analogues, traces; crotonylene, 31; terene, 12; hydrocarbons, transformed into fixed polymers, 83; diacetylene and analogous hydrocarbons, 15 (estimated). Berthelot believes that these products arise from certain fundamental reactions, already expressed in his pyrogenic theory, between the four fundamental hydrocarbons—acetylene, ethylene, dimethyl, and methane. Together with hydrogen, these bodies form a system in equilibrium such that at a red heat they are all formed from any one of them present at the start. If marsh gas or methane be taken, the olefine series is directly produced from it by the abstraction of hydrogen and polymerization. Acetylene produces benzene (which is only triacetylene) as well as the analogous polymeric series. The more complex bodies come from the more simple ones. Thus acetylene and benzene give styrolene; acetylene and styrolene, naphthalene; acetylene and naphthalene, acenaphtene; and benzene and styrolene, anthracene. Moreover at a dull red heat acetylene unites with ethylene to form ethylacetylene, and with propylene to yield propylacetylene, the former identical with crotonylene, the latter with terene. In the light of this research, it is obvious that the present method of determining by analysis the illuminating power of a gas, based as it is on the assumption that the chief illuminants are ethylene and acetylene, is worthless.—*Bull. Soc. Ch.*, II., xxvi., *August*, 1876, 104.

PHYSICAL ISOMERISM.

While observing the properties of a new compound discovered by him, called nitrometachlor-nitrobenzene, Laubenheimer has discovered the best example hitherto known of physical isomerism. The substance mentioned is prepared by metachlor-nitrobenzene with a mixture of fuming nitric acid and sulphuric acids, with the aid of heat. On pouring the whole into water a yellow oil falls down, which on cooling solidified almost completely to a crystalline mass. On investigation, it appears that this substance exists in four distinct modifications, three of which are solid and one liquid. Since, chemically, there can be but one body produced in the above treatment, it is obvious that the isomerism here is purely physical; a conclusion confirmed by the ready conversion of the four forms the one into the other. The first, or

α-modification, is obtained by dissolving the crude product in warm alcohol and allowing it to cool. At first an oil separates, in which after a time crystals appear, which may be developed into thick prisms on repeating the operation. These prisms are monoclinic twins, with a well-defined cleavage, having the plane of the optic axis perpendicular to the plane of symmetry. They show strong negative double refraction, and fuse at 36.3° Centigrade. Any of the other forms when melted crystallize in this form on touching the liquid with a crystal fragment of it. The second, or β-modification, is obtained by fusing the former completely at 39° to 40°, and allowing to cool. Long concentric groups of prisms are formed, which are monoclinic, but which are without cleavage, have a different axis ratio and axis angle, and fuse at 37.1°. Crystals of α after five weeks yield β on crystallization from alcohol. The third, or γ-modification, crystallized out of the aqueous solution into which the mixture was poured in preparing the substance. It is also the most permanent form of all, both α and β being converted into it in a few weeks, though becoming turbid in twenty-four hours. The crystals are orthorhombic, show a distinct cleavage, and have a moderate but positive double refraction. They fuse at 38.8°. The liquid modification is obtained whenever either of the solid forms is heated to 42°. On cooling it remains permanently liquid. In accounting for this physical isomerism, Laubenheimer assumes Naumann's hypothesis that physical molecules are formed by the aggregation of chemical molecules, and believes that the larger the number of chemical molecules the more stable the body. The fusing-point of the body containing the less complex physical molecule is therefore lower, the specific gravity is less, and specific heat is greater.—35 *C*, IX., *June*, 1876, 760.

THERMO-CHEMISTRY OF OZONE.

Berthelot has studied thermo-chemically the formation of ozone. Pure and dry oxygen was passed through a tube where it was subjected to the influence of the silent electric discharge, and then into a calorimetric flask containing 500 cubic centimeters of a solution of arsenous acid in hydrochloric acid, previously graduated. At the end of twenty to thirty minutes, six to nine liters of oxygen had passed through the calorimeter, and its temperature had been raised one third of a degree. By passing the oxygen current alone through the apparatus under the same conditions for an equal time, both before and after the experiment, the thermal data were rendered complete. The arsenic solution was treated with a graduated solution of potassium permanganate in excess, and then titered back with a standard solution of oxalic acid. In this way the amount of arsenous acid oxidized, and consequently the amount of ozone absorbed, was determined. In two experiments, the oxygen absorbed was 30.3 and 51.9 milligrammes, corresponding to 90.9 and 155.7 milligrammes of ozone; the heat set free being 118.2 and 223.7 calories respectively. Whence for one molecule, 48 grammes, the heat is equal to +68.8 calories. Subtracting from this the heat produced in the oxidation of a molecule of arsenous acid, determined by Favre and by Thomsen to be +39.2 calories, we have +29.6 calories for the heat set free by the conversion of one molecule of ozone into oxygen, and of course −29.6 calories in the reverse process. This value is one half greater than that given in the formation of the same volume of nitrogen monoxide or of chlorine monoxide, in both of which the value is −18. It is even two thirds of that given in the formation of nitrogen dioxide, 43.3. In the three cases of direct synthesis of compound gases by the electric spark, ozone, nitrogen tetroxide, and acetylene, the heat values are all negative, being −29.6, −24.3, and −64 respectively; an obvious proof of the function of electricity in chemical synthesis. Ozone is therefore a body in whose formation heat is absorbed, and whose activity is due consequently to this heat, which when it combines is again set free. It is a magazine of energy stored up under the influence of electricity. This fact is the more remarkable when it is remembered that ozone is condensed oxygen, and that condensation sets free heat.—6 *B*, LXXXII., *June*, 1876, 1281.

MEDICO-LEGAL EXAMINATION FOR ARSENIC.

In a series of researches undertaken for the purpose of determining certain physiological questions (and in the course of which it was discovered that arsenic showed a special tendency to localize itself in the nervous tissues, especially in the brain and spinal cord), Gautier was led to suspect the quantitative accuracy of the methods for the separation of arsenic from the tissues which are ordinarily made use of, and to devise an improved method of his own. The improvement has reference in the first place to the separation of the arsenic from the organic matter, and in the second to obtaining it in a weighable form. For the former, 100 grammes of the finely divided animal matter is placed in a porcelain capsule with 30 grammes of pure nitric acid, and moderately heated. The mass at first liquefies, and then thickens and becomes orange-colored. The capsule is taken from the fire and 5 grammes of pure sulphuric acid are added. Heat is applied till white fumes appear, 10 or 12 grammes of nitric acid are allowed to flow drop by drop on the residue, and the whole is heated to carbonization. An easily pulverizable mass is thus obtained, which is exhausted with boiling water, filtered, the filtrate reduced with a few drops of hydro-sodium sulphite, and precipitated as usual with hydrogen sulphide. The improvement in the determination consists in passing the gas evolved from a Marsh apparatus through a tared glass tube heated to redness by charcoal for a length of 20 to 25 centimeters. After the arsenic is all carried over, the tube is detached and again weighed. The difference is the amount of arsenic, the results being accurate. Five milligrammes of arsenous oxide mixed with 100 grammes of muscular tissue gave when treated by this process rings weighing respectively 3.72 and 3.67 milligrammes; the theoretical quantity being 3.79.—*Bull. Soc. Ch.*, II., xxiv., *October*, 1875, 250.

E. MINERALOGY AND GEOLOGY.

THERMO-ELECTRIC PROPERTIES OF MINERALS.

An interesting series of experiments has been carried on by Hankel upon the thermo-electrical properties of some mineral species. It is a familiar fact that crystals of tourmaline when subjected to a decided change of temperature develop electricity, and those crystals which are differently formed at the two extremities show at one end positive and at the other negative electricity. Crystals of other species, as, for instance, topaz, which do not possess this hemimorphic character, act differently when subjected to the same conditions, as shown by Hankel. The electricity which is developed at both extremities of the same axis is alike—for instance, positive—while the opposite or negative electricity is shown at both extremities of another axis. The investigations just made public have special reference to several species whose crystals are developed alike in the direction of all lateral axes, but this development is different from that in the vertical direction. For example, crystals of apophyllite, when subjected to sudden cooling, develop at the extremities of the vertical axis positive electricity, while laterally—that is, in all the planes of the prisms—the electricity is negative. Also crystals of vesuvianite (idocrase) show similar relations, the terminal plane and the pyramidal plane have one character, positive; while the prismatic planes, corresponding to the lateral axes, are negative. Crystals of emerald and beryl have not a very decided electrical character, but here also it is true that the end planes have one electrical character and the lateral planes another.

It may be added that in other species, as, for instance, prehnite, Hankel has found a large number of positive and negative electrical poles distributed over the surface of a crystal.

MINUTE WORK IN MINERALOGY.

As an example of minute work in mineralogy, it may be interesting to note the recent investigations of Baumhauer upon the etchings which may be produced on the crystalline faces of many mineral species. Thus on crystals of calcite minute triangular depressions may be produced by subjecting them to the working of dilute hydrocholoric acid; crystals of salt exposed to moist air for a little time show depressions which have the form of a four-sided pyramid. Hydrofluoric acid, also, will in a few moments produce distinct though microscopic etchings on a thin plate of ordinary potash-mica, while a corresponding result is obtained by treating crystals of garnets with caustic alkalies. The interest of these and similar experiments is that they give us an insight, as nothing else can, into the molecular structture of the crystals, or, in other words, the way they have been built up. Some authors have even maintained that the form of the etchings produced must be that of the fundamental molecules, and, though this may not be sustained, the relation that subsists must certainly be a close one.

MINERAL STATISTICS OF THE COLONY OF VICTORIA.

From a report upon the mineral statistics of the colony of Victoria for the year 1874, which has lately been presented to Parliament, we glean the following facts: The amount of gold raised in the colony in 1871 was 1,290,844 ounces; in 1872, 1,218,094 ounces; in 1873, 1,162,492 ounces; and in 1874, 1,105,115 ounces. The value of the machinery and appliances used on the gold-fields in 1874 was £2,078,936 (or something over $10,000,000), the total area of the auriferous district worked upon was 1063 square miles, and the number of distinct quartz reefs was 3398. One hundred and eighty tons of silver ore were raised during the year, from which 11,906 ounces of silver were extracted.

DAUBREITE.

The new mineral *Daubreite*, from the bismuth mine of Cerro de Tazna, in Bolivia, has lately been described by Domeyko. It occurs in yellowish or grayish earthy masses, in which occur many crystalline lamellæ of a pearly lustre, and opaque. Specific gravity about 6.5. In composition it is an oxychloride of bismuth.—6 *B*, *April*, 1876, 922.

GARNIERITE AND NOUMEITE.

Garnierite and *Noumeite* are two new nickel minerals found near the town of Noumea, in New Caledonia, and described by Professor Liversidge, of Sydney. They are very similar to each other in appearance, though they are considered to have some distinguishing characters. They are amorphous, of a bright apple-green color, and so soft as to be easily polished by rubbing with the thumb-nail. The economic importance of these minerals lies in the fact that they contain about twenty-five per cent. of nickel-oxide, which, as they occur in large quantities, makes them valuable as nickel ores. They both occur filling veins and fissures in serpentine.

SIDERAZOT, A NEW MINERAL.

Professor Silvestri, of Turin, proposes the name *siderazot* for a native iron nitride or compound of iron and nitrogen which he has detected among the fumarole products of Mount Ætna. The eruption of August, 1874, was especially interesting in that, while commencing violently, the duration was short, and the end came suddenly. It was at this time that the new mineral was found, appearing as a thin incrustation, of gray metallic lustre, coating the lava. It contained chemically ninety-one per cent. of iron and nine per cent. of nitrogen. The author makes some remarks upon the possible method of formation of this rare compound, but the matter seems to be yet involved in much uncertainty.

FRIEDELITE.

Friedelite is a hydrated silicate of manganese, discovered by Bertrand at the mine of Adervielle, valley of Louron, in the Pyrenees. It occurs in crystalline masses of a carmine red color, with a specific gravity of 3.07. It crystallizes in the rhombohedral system, and possesses in a high degree the property of doubly refracting light.—6 *B*, *May* 15, 1876.

KAOLIN IN NEBRASKA.

It has lately been reported that a deposit of kaolin, of not less than thirty feet in thickness, and underlying about 100 acres, has been discovered in the neighborhood of Omaha.

It appears that the deposit crops out along a bluff for over half a mile, with but a few inches of earth covering it. The character of the material is said to improve with the depth, the upper portions being coarse and granular in texture, while lower down it becomes progressively finer and whiter. It is represented to be remarkably free from foreign impurities, and adapted for the manufacture of a great variety of articles in large demand in the Western country. There is a railroad, and an abundance of timber and water in the neighborhood.—6 *D*, 32, 212.

TWO NEW MINERALS, MELANOPHLOGITE AND ÆRINITE.

Two new minerals have been announced by Professor Von Lasaulx, of Breslau. The complete descriptions have yet to be given. One of these minerals is called *melanophlogite*, the name having reference to what is regarded as one of its distinctive characters, that of turning black upon ignition. It occurs in minute cubes upon sulphur from Girgenti, in Sicily. Sometimes a thin incrustation of quartz covers the crystals of sulphur, and upon this rests the new mineral. Its chemical composition is still uncertain, but it is supposed to be a hydrated silica. The material examined contained also some iron and lime, but probably only as impurities.

The second new mineral referred to has received the name *ærinite*. It is an essentially iron silicate, and occurs in masses with a scaly structure. Its only decided character is its blue color, to which it owes its name. The locality is uncertain, though the specimen examined purported to be "from Spain."

MEXICAN ONYX.

This beautiful stone, so much admired in the Mexican exhibit at the Centennial Exposition, has been analyzed by Damour. It is a mixture of the carbonates of lime, magnesia, iron, and manganese, containing about 89.5 per cent. of the one first named. Specific gravity, 2.77.—35 *C*, IX., 848.

NEW VANADIUM MINERALS.

Roscoelite, described recently by Dr. F. A. Genth, is a brownish micaceous mineral from California. Its chief constituents are vanadic acid (about 20 per cent.), silica, alumina, and potash.

Psittacinite, also analyzed by Genth, is from the Iron Rod Mine, Silver Star District, Montana. It had previously been mentioned as supposably a tellurate of lead and copper. Now, upon actual analysis, it proves to be, not a tellurate, but a hydrous vanadate of the above-named metals, containing some 19 per cent. of vanadic acid. It occurs in very thin, cryptocrystalline coatings, varying in color from siskin to olive green.—1 *A*, *August* 25.

THE BORAX LAKE OF CALIFORNIA.

It appears that the incredulity with which statements concerning the borax lake have been received in England has been considerably lessened by supplies of the material coming to the London market. The pottery districts are especially interested in the discovery. Accounts set forth that very extensive works are now nearly completed for the refining and purifying of this borax for shipment. Stimulated by the action of the railroad company, the borax company has put up large works, and expects to turn out from twenty to fifty tons of the mineral per day. The deposit of borax extends over an area of eighteen miles in length by six to eight miles in width, covered with crude borax to the depth of three to five feet. The crude mineral averages from twenty to forty per cent. of the pure salt.—*American Exchange and Review*, *June*, 1875.

ACHREMATITE.

A new mineral, bearing the title of *Achrematite*, has been described by Professor Mallet, of the University of Virginia. It came into his possession labeled "Silver ore from the mine of Guanaceré, state of Chihuahua, near the Durango line," and, indeed, resembled one of the haloid compounds of silver. Analysis, however, showed it to be a molybdo-arsenate of lead, intermixed with finely divided ferric hydrate. —21 *A*, *November*, 1875.

NEW MINERALS.

Scacchi, in studying the mineral products of the eruption of Vesuvius of April, 1872, has described quite a number of new species. Most of these seem to be saline bodies; one is simply hydrofluoric acid, and is named hydrofluorite;

another, proidonite, is fluoride of silicon. Atelite is a hydrated oxychloride of copper; cryptohalite consists of ammonium silicofluoride; chloraluminite is aluminic chloride. Chlorothionite contains copper, potassium, chlorine, and sulphuric acid; pseudocotunnite is a double compound of the chlorides of potassium and lead. Other species described by Scacchi are chlorocalcite, erythrosiderite, chloromagnesite, cupromagnesite, and microsommite. Associated with all these were the previously known minerals hematite, magnetite, tenorite, sylvite, halite, sal ammoniac, molisite, aphthitalite, anhydrite, pyroxene, byssolite, chrysolite, and apatite.—4 *D*, *December*, 1875.

DREDGING FOR AMBER.

According to an official report from Memel, Germany, an establishment has been organized for gaining amber by dredging for it in the Kurische Haff, near the village of Schwarzorts, situated about twelve miles south of Memel. It has been known for many years that amber existed in the soil of this place, from the fact that the dredger employed by the government for the purpose of clearing away the shallow spots near Schwarzorts which impeded navigation brought up pieces of amber, which were duly appropriated by the workmen, and at the time no particular attention was paid to the matter. Some time afterward, however, some speculators associated, and made an offer to the government not only to do the dredging wherever required at their own expense, but to pay a daily rent, provided the amber which they might find should become their property. This proposal was accepted, and the rent fixed at fifteen thalers, and later at twenty-five thalers, for each working day. The dredging was begun with four machines worked by men and one by horses. Judging from the extended business transactions in this matter, its results must have been extremely profitable. At present the work is carried on with eighteen steam-dredges and two tug-boats, the whole managed by about 1000 laborers.—*March* 5, 1875, 170.

INTERESTING IRON METEORITE.

The iron meteorite from Rittersgrau, Saxony, which fell in the year 1833, has recently been described. The weight of the piece, which belongs to the School of Mines at Freiburg, is 173 pounds. It has recently been cut in two by the operation of fourteen steel saws, the cutting occupying two complete months; the smaller of the two portions thus obtained, weighing about forty-eight pounds, has been subjected to chemical and other experiments. The area of the section thus laid bare was about 100 square inches. Some small pieces have been sold at such prices as to warrant the statement that the entire mass, at the same rate of prices, should be valued at about $5000. The suggestion is plausible that the three meteors found at Rittersgrau, Steinbach, and Reitenbach belong to one and the same meteor which fell in the year 1164.

AN INTERESTING AEROLITE.

In meteoric astronomy, a very suggestive note has been published by J. Lawrence Smith. He states that the mass of meteoric iron which fell on the 1st of August, 1835, near Charlotte, Dixon County, Tenn., is one of exceeding interest, as it is one of four cases of the fall of masses of iron free from earthy matter. The meteor itself has been preserved in the cabinet of Professor Troost for the past forty years. The meteorite displays the Widmannstättian figures with exquisite beauty, and also the marks to which Mr. Smith some time ago gave the name of Laphamite figures. The gases contained in this iron have been examined by Professor Wright, who attributes to it seventy-one per cent. of hydrogen, fifteen per cent. of carbonic oxide, and thirteen per cent. of carbonic acid. The meteorite does not appear to have been heated in the atmosphere to a sufficient degree of intensity to fuse the surface. On the whole, the specimen referred to is the most interesting piece of meteoric iron yet known.—4 *D*, X., 349.

BORING FOR COAL.

Siegert gives the details of a deep bore made at Chemnitz in search of coal. Many previous attempts had been made even at Chemnitz to develop coal strata. The present attempt was made with a diamond borer, and was begun on the 4th of November, 1874, and progressed at the rate of 2.85 meters per day. The cores as taken from the borer have been preserved in the School of Mines. The depth to which the bore was extended was 210 meters, of which the first thirty-five were porphyritic stone, and the latter 175 a red-colored sandstone and conglomerate, and not a trace of coal was found, or is to be expected. Observations of the temperature at various depths seem not to have been undertaken.—*5th Ber. Nat. Gesells., Chemnitz*, 1875, 244.

COAL-FIELDS OF SPAIN.

In a paper lately read before the French Society of Engineers, the area of the coal-fields of Spain was estimated to equal 150,000 hectares (the hectare equals 1.47 acres). From these deposits only about 500,000 to 600,000 tons of mineral are annually produced, while in Belgium, with the same area, the production is 10,000,000 tons. The Spanish coal-fields are in the provinces of Castile, Leon, and the Asturias. The process of extraction is described as being quite rude and imperfect.—17 *D*, XX., 56.

SECTIONS OF COAL.

Dr. C. Johnson gives the following as the method adopted by him in preparing sections of coal: 1. Macerate suitable pieces one quarter or one half inch thick in liquor potassæ until they swell or soften. 2. Soak for a few hours in pure water, and drain. 3. Macerate in nitric acid until the color changes from black to brown. 4. Soak for a few hours in water, and drain. 5. Put in alcohol for a few days. 6. Fasten in a cutter with paraffin, and make sections, the sections to be mounted in balsam after successive immersions in absolute alcohol and oil of cloves.—*Medical News, Cincinnati, July*, 1875.

COMPOSITION OF CORAL.

The composition of coral has been carefully investigated by Professor Dana. Ordinary corals have a hardness a little above that of common limestone or marble, giving out a ringing sound when struck with a hammer. This may be owing, he considers, to the carbonate of lime being in the state of aragonite. It is a common mistake to suppose that coral, when first taken from its watery bed, is soft, and hardens through exposure. The live coral may feel somewhat slimy in the fingers, but if the animal matter be washed away it is found quite hard. Chemically the chief constituent of the whole is carbonate of lime, in the proportion of ninety-five to ninety-eight parts in one hundred, with one and a half to four parts of organic matter, and some earthy ingredients, such as phosphate of lime, with a trace of silica, amounting usually to less than one per cent. Forchhammer found 2.1 per cent. of magnesia in Corallium rubrum, and 6.36 in Isishippuris. The sources of these constituents are the sea-water and the ordinary food of the polyps, the process of absorption, assimilation, and secretion going on in them as in all animal organizations.—*Engineer*, XL., 1034, 281.

VOLCANIC DUST.

A microscopic examination of the dust which fell in parts of Sweden and Norway on the night of March 29–30, 1871, has led M. Daubrée to believe that it proceeded from a volcanic eruption in Iceland. The dust was found to be composed of fragmentary transparent grains, some colorless, others more or less brownish-yellow. Minute crystals of feldspar and pyroxene were recognized.—*Academy*, *May* 8, 1876.

VOLCANIC HISTORY OF IRELAND.

In the annual address delivered before the Royal Geological Society of Dublin, Professor Hull has given an interesting account of the volcanic history of Ireland. He shows that in the Lower Silurian there are numerous examples of volcanic rocks in several parts of the island; thus in the counties of Wicklow and Waterford there are numerous sheets of felstones and porphyries accompanied by beds of ash and volcanic breccia, and similar conditions in other districts. All of these volcanic rocks are to be regarded as having been erupted from vents sporadically breaking out over the sea-bed of the period, they having been in turn covered up by fresh sediments. In the Upper Silurian there is little evidence of volcanic action; in the Devonian there are more, and in the Carboniferous they are still more decided. Coming down in the geological history, it is necessary to pass over to the Tertiary before the products of the volcanic fires are again met with. In this period they were very active, and the area now occupied by the volcanic rocks in the northeastern part of Ireland may be estimated at 2300 square miles, extending moreover to the west coast of Scotland. These last volcanic eruptions are some of the most extensive that the world has ever known, and it is to them that are to be referred the strange beauties of the Giant's Causeway and Fingal's Cave.

ELEVATION OF THE PACIFIC COAST OF SOUTH AMERICA IN RECENT TIMES.

Mr. Alexander Agassiz, in his recent trip to Peru, found occasion to conclude that the Pacific, within a comparatively recent time, extended through gaps in the Coast Range, and made an internal sea which stood at a height of not less than 2900 feet, and probably much above this. This is proved by the fact of the occurrence of coral limestone 2900 or 3000 feet above the sea-level, about twenty miles in a straight line from the Pacific. There are now no coral reefs on the west South American coast south of Cape Blanco, near the equator, owing probably to the cold oceanic currents; and this generalization in regard to the previous relations of land and water is one of very great interest. The corals referred to are of modern aspect, although the species are undescribed. The fact that there are extensive saline basins at a height of even 7000 feet on the coast of Peru would seem to indicate that the submergence was at one time still greater than that suggested. Indeed, eight species of *Allorchestes*, a salt-water genus of amphipod crustaceans found in Lake Titicaca, would seem to indicate that this lake, 12,500 feet above the sea, must have been at one time at the sea-level.—4 *D*, p. 499.

THE GLACIAL EPOCH IN THE ROCKY MOUNTAINS.

In reference to the glacial phenomena still to be traced in the Rocky Mountains, Professor Powell, in his recently published report on the geology of the eastern portion of the Uinta Mountains, states that there has been glacial action in the Uinta Mountains. There are found undoubted morainal deposits. The deep valleys that lie at the foot of the axial peaks of this great range have been beds of extinct glaciers. Morainal deposits and glacial grooves are found in very many of these valleys. Often the valleys are so choked with the materials thus accumulated by the action of ice that it is with great difficulty one travels across them. The evidences of the glacial epoch are abundant, but they are found only high up on the Uinta Range, and the gravels and boulders of the low land are testimony only to the ordinary action of drift agencies. The gravel beds on the low lands are true drift.—*Powell's Report of* 1876, p. 171.

SUB-ALPINE LAKE BASINS DUE TO GLACIAL EROSION.

M. Istaldi, in discussing the subject of the glaciers of the Pliocene epoch which have been studied by Desor in Switzerland, shows, (1) That the existence of the sub-alpine lacustrian basins is intimately connected with that of the glaciers at the epoch of their greatest extension; that, in fact, the Alpine valleys and the Apennine valleys, and the basins of the lakes of Northern Italy, are all basins of erosion; that, (2) On the other hand, the thirty valleys which pour their waters into the great basin of the Po open into only six moraine amphitheatres. (3) All sub-alpine lakes are situated within these six amphitheatres, which are the work of the ancient glaciers. (4) There is no moraine amphitheatre without lakes. (5) There is no trace of lakes beyond the limits of these amphitheatres. (6) The breadth and length of the lakes are proportional to the dimensions of the moraine amphitheatre, which is itself in proportion to the dimensions of the zone of sedimentary earth. He concludes, therefore, that if the glacier period had not taken place, there would have been no sub-alpine lakes. An examination of the physical conditions of the Pliocene, and the fauna which they contain, shows that the climate was at this epoch warmer and dryer than today.—*Atti della Roy. Acad. della Scienza, Turin*, 1875, X., 490.

THE DEPOSITION OF FINE SEDIMENTS.

Dr. T. Sterry Hunt states, in reference to the question of the deposition of fine mud in the Mississippi, that the deposited matter requires from ten to fourteen days to subside; but that if sea-water or salt or sulphuric acid be added to the turbid water it becomes clear in from twelve to eighteen hours. Thus is explained the rapid precipitation that occurs when the river-water mixes with the salt waters of the Gulf of Mexico. The cohesion of water diminishes when it holds saline matter in solution, as was said by Guthrie and was verified by Dr. Hunt. He found that the addition of eight parts of chloride of calcium to 1000 parts of water reduces the size of drops to one ninth, and the precipitation of suspended clay is made very rapid when a strong solution of salt is employed.—12 *A*, X., 277.

FORMATION OF FLOOD-MARKS AND GRAVEL BANKS.

In a communication on the high flood-marks on the banks of the River Tweed, made by D. M. House to the Royal Society of Edinburgh, the author maintains that when the sea stood at higher levels, all the rivers of the country must have likewise flowed in channels of higher levels, and that the flood-marks in question were formed during that condition of affairs, and not when the rivers were flowing in their existing channels. With reference to the formation of ridges of drift deposits, the author maintains that they were not due to ice or to river action proper, but that as similar ridges of sand, gravel, or mud are formed now in the sea, so they may have been formed when the districts in question were under the sea.—*Proceedings Royal Society of Edinburgh*, VIII., 559.

F. GEOGRAPHY.*

ANEROIDS AND HYPSOMETRY.

In a supplement to the *Meteorologia Italiana*, Dr. Grassi gives the results of experimental research upon aneroid barometers. His aneroids were compared with standard mercurial barometers, both during journeys to high mountains and during exposure in the ordinary receivers of air-pumps. Among the results given by him, we note that, in addition to the generally recognized fact that the aneroids are subject to sudden changes when at all roughly handled, each aneroid has a system of corrections peculiar to itself, and the further fact that sudden jumps peculiar to an aneroid are produced at corresponding or symmetrical points, according as the pressure is diminished or increased.

In a second paper upon the correlated subject of barometric hypsometry, he calls attention to the important works of St. Robert and Ruhlmann, and shows that the formula deduced by the former investigator leads to quite as reliable results as that of the latter. In an appendix he gives a convenient table for calculating altitudes, for the use of Italian meteorologists, based upon the formula of St. Robert.

NEW HYPSOMETRIC TABLES.

The tables constructed by Biot, in 1811, for the computation of altitudes by means of barometric observations, were as convenient as could be desired for this purpose, but have recently been published in a much greater fullness by Kiefer, of Tiflis, who has also given them a still more convenient form. He states that he separates the original Biot's formula into three portions, depending respectively on, first, the pressure; second, the pressure and the temperature; and, third, the pressure, temperature, and altitude. The advantages which the new tables of Kiefer possess over the older ones of Biot are, first, all interpolations are avoided, and there is left for the computer only the simplest operations, viz., addition and subtraction, which can even be executed upon the abacus that is so widely used in Russia. Second, the terms depending upon the temperature of the air and the altitude are separated from those that are independent of these arguments; so that we see directly the influence of these upon the result. Third, notwithstanding that the extent of the new tables does not exceed 114 small pages, yet is the range so extended as to cover any altitude that can possibly occur even in the Caucasus. Kiefer's tables do not take account of the moisture in the atmosphere, because, as he says, the computations that introduce that argument give results differing from the geodetic determinations more than if moisture is omitted.—*Biot's Tafeln, computed by Kiefer, Tiflis*, 1874.

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* The fullness of the systematic account of the progress of geographical science in the Summary enables us to reduce the amount of space usually devoted to this subject in the body of the "Annual Record."—*Ed.*

NEW FORM OF MERCURIAL HORIZON.

Those who have had frequent occasion to observe the heavenly bodies as reflected from a bath of mercury will welcome the announcement that it is possible to construct such a bath in a manner to diminish, if not entirely obviate, the very annoying vibrations to which the mercury is subject even when the origin of the vibration is unknown. Such a bath of mercury, established upon a pier of its own, entirely isolated from the building, has been known to tremble under the influence of vibrations communicated from railroad trains, or the blasting of rocks, from two to five miles distant. In the neighborhood of a large city the surface is never quiet by day or night. In order to obviate this annoyance, it is well known that Professor Airy, of Greenwich, suspended the basin containing the mercury from the fourth of a set of four frames, each of which was suspended from the other by threads of India rubber. By this means the mercury was relieved from the influence of the minute vibrations to which the ground near London is continually subject. Mr. Lane, of the Coast Survey, however, announces that if in the bottom of the basin, near its edge, we cut a circular trough, such that the greater mass of the mercury may run into it, we may leave over the greater portion of the remaining bottom surface of the basin a thin layer of mercury, possibly the one hundredth of an inch deep, which will not be troubled by the ripples that originate near the edges of the basin. It is easy, he says, by gentle taps upon the trough, to observe these ripples starting from the edge, but quickly dying out as they come upon the plateau where the mercury is relatively shoal. It might be anticipated that a slight inclination of the basin would materially alter the horizontality of the surface of the mercury. He states, however, that this is not the case to any injurious extent, the momentary tilting of the mercurial surface being immediately followed by a resumption of its horizontality. Mr. Lane's arrangement for procuring a thin, steady horizontal mercurial film seems to be an improvement upon that proposed many years ago by Lamont, and will doubtless be found exceedingly convenient in many astronomical observations, if it be not injuriously affected by inequalities of temperature, as Lamont showed was the case in his own apparatus.—*Coast Survey Report*, 1871, 189.

CORRECTION OF ASSUMED ALTITUDES IN THE UNITED STATES.

Mr. James T. Gardner, the Geographer of the United States Geological and Geographical Survey of the Territories under Professor F. V. Hayden, has published an elaborate discussion of the evidence upon which rested the supposed altitudes of leading points in the Northern and Western United States, our great lakes, rivers, cities, mountains, etc. He had before him a collection of over 1200 railroad and canal profiles, and among this mass were many conflicting statements. Corrected profiles were joined together into various lines extending from ocean tide-gauges to the interior of the country. These lines focusing at great railway centres, gave the means of determining the altitude of each of them by a number of independent methods. Different results accord so closely, and evidence is given with such completeness, that Mr. Gardner's work must be considered to have established the altitudes of the United States. The height of the mean surface of Lake Erie is shown to be 573.08 feet, and of Lake Michigan, 589.15 feet above the sea. This differs considerably from former results, and Mr. Gardner points out the old sources of error. The whole lake region is changed by the same amount as the lakes.

The following are some of his results:

	Feet.
The Cincinnati City Directrix	439.74
Pittsburgh, Main Depot track	746.00
Harrisburg, Pa., Railroad Depot track	819.91
Philadelphia, City datum	8.78
Albany, mean tide in river	4.84
Lake Champlain	100.84
Lake Ontario, mean surface	250.00
Indianapolis, Main Depot track	721.75
Cairo, city base of levels	291.28
St. Louis, City Directrix	428.29
Chicago, City Directrix	587.15
Rock Island, C. R. I. and P. Depot track	568.68
Burlington, Iowa, Main Street Depot	531.61
Omaha, top of abutments of railroad bridge	1,049.40
Kansas City, mark of high water of 1844	770.77
Denver, K. P. R. R. Depot track	5,196.58
Cheyenne, U. P. Depot track	6,075.28
Pike's Peak	14,146.68
Mount Lincoln	14,296.66

These heights are largely different from previous estimates. Our great railway centres and entire states are raised 10 to 115 feet in altitude. The whole of some parts of the continent seems to be much higher above the sea than was supposed. One of the most interesting results of the investigation is that it shows our American railroad levels to be very accurate when long lines are considered. The New York Central and Lake Shore and Michigan Southern Railroads joined with the Illinois Central and Southern Railroads to New Orleans make a continuous line of levels 1800 miles long from New York Bay. They reach the Gulf of Mexico with an error of only two and a half feet. The two great independent lines—the Union Pacific and the Kansas Pacific Railroads—reach Denver with a difference of only five feet. Such accuracy in American leveling speaks well for our engineers. The careful determination of altitudes of high and low water at a number of points on the Ohio, Mississippi, and Missouri Rivers is one of the most important contributions, establishing, as it does, the true fall of these rivers at different stages of water—a subject of which our previous knowledge was very inaccurate. Mr. Gardner closes with a list of altitudes of 150 carefully located points. Those especially interested in the paper will find it in the Report of the United States Geological and Geographical Survey under Professor F. V. Hayden for 1873.

THE BATHOMETER OF DR. C. W. SIEMENS, F.R.S.

In a report to the Secretary of the Navy on the Loan Exhibition of Scientific Instruments at South Kensington, by Professor E. S. Holden, U. S. N., are some interesting remarks upon this ingenious instrument.

Professor Holden says: The best description of this instrument is to be found in *Nature* for March 30, 1876, from which the following account is taken: A paper has been presented to the Royal Society "On determining the depth of the sea without the use of the sounding-line," by Dr. C. W. Siemens, who gave at the meeting of the 24th of February, 1876, a description of the instrument which he has designed with this object. He commenced by giving a mathematical statement of the effect of local attraction, to a certain depth, on a body placed at the surface of the earth, assuming it to be of uniform density, spherical in form, and unaffected by centrifugal action. For small values of depth (h) this attraction is $2\pi h$. The original formula from which this is adduced is:

$$2\pi h\left(1-\frac{2}{3}\sqrt{\frac{h}{2R}}\right),$$

and by substitution of $2R$ for h in this, Newton's statement of the total attraction $\frac{4}{3}R\pi$ is obtained.

Now, if in place of the solid substance which forms the exterior crust of the earth, whose density may be taken to be the mean density of superficial rock, water, a material of less density, is substituted, it is shown that the total attraction must be diminished, and the measure of this diminution is a measure of the depth of light substance which has been substituted for heavy. If we were in possession of the exact mean density of the earth, of that of the surface-rock, and of sea-water, a scale could be calculated beforehand to show what depth would agree with a certain diminution of the measured effect of gravitation. Such an approximate calculation was made in designing the instrument, but Mr. Siemens has preferred to compare the readings of the instrument with actual soundings, in order to obtain a scale.

The instrument, which is called a bathometer, consists of the following parts: A weight, being a column of mercury affected by variation of gravitation; a counterbalance, being springs unaffected by variation of gravitation; and an arrangement by which variations in gravitation can be read as depths in units. The column of mercury is maintained in a vertical steel tube having cup-like extensions, the lower portion being closed by a corrugated diaphragm of thin steel plate, and the upper portion containing an aperture for filling the instrument, having a screw stopper. The internal diameter of the tube is reduced at the upper portion, in order that the vertical oscillations of the mercury produced by the motion of a vessel in a sea-way may be reduced to a minimum; and the instrument is suspended in a universal joint above its centre of gravity, so that it may always hang in a vertical position at sea, and is inclosed in an air-tight casing, so that it may not be under the influence of atmospheric changes. The weight of the column of mercury is balanced at the centre of the diaphragm by the elasticity of the steel springs, and the *modus operandi* of the instrument is evident; as the mercury diminishes in potential through the effects of diminished attraction, the action on the springs diminishes, and these shorten upon themselves.

There are some peculiarities in the mechanical arrangement of the instrument which repay examination. Both ends being open to the air, its indications are not affected by variations of atmospheric pressure. With regard to temperature, the instrument is *parathermal.*

Professor Holden states that by the courtesy of Dr. Siemens he was enabled to see the manuscript account of soundings taken with this instrument on board the *Faraday* in October and November, 1875, and in March and April, 1876. During her voyage across the Atlantic at that time frequent soundings were made with the piano-wire sounding apparatus of Sir William Thompson, and at each one of these soundings the bathometer was read by Dr. Hicks, who had it under his charge. The results are exhibited in the following table:

A.	B.	A−B.	(A−B)÷B.
Bathometer.	Piano-wire.	Error of Bathometer.	
Fathoms.	Fathoms.	Fathoms.	Proportion of Error.
201	197	+ 4	+0.020
99	100	− 1	− .010
63	54	+ 9	+ .185
82	82	0	.000
218	214	+ 4	+ .019
78	69	+ 9	+ .130
56	54	+ 2	+ .037
55	54	+ 1	+ .017
20	56	− 6	− .107
47	54	− 7	− .130
50	58	− 8	− .138
66	69	− 3	− .043
82	73	+ 9	+ .122
56	47	+ 9	+ .171
49	46	+ 3	+ .065
80	69	+ 11	+ .160
111	100	+ 11	+ .110
215	200	+ 15	+ .075
69	64	+ 5	+ .078
80	80	0	.000
86	86	0	.000
68	76	− 8	− .105
388	353	+ 35	+ .099
799	698	+101	+ .143
607	503	+104	+ .206
2789	2516	+273	+ .108
2388	2320	+ 68	+ .029
1907	1861	+ 46	+ .025
1615	1700	− 85	− .050
Mean...........................			0.083

The following soundings were taken in March and April, 1876, by Alexander Siemens, Esq., near Nova Scotia. Some sources of error had in the meanwhile been removed:

A.	B.	A−B.	(A−B)÷B.
90	90	0	0.000
94	92	+ 2	+ .022
95	94	+ 1	+ .011
107	101	+ 6	+ .059
105	105	0	.000
64	64	0	.000
64	61	+ 3	+ .049
56	53	+ 3	+ .057
66	68	− 2	− .030
29	27	+ 2	+ .074
43	38	+ 5	+ .132
Mean...........................			0.039

It will be seen from the table that the mean error is a little over eight per cent. for the first trials, during which time the instrument (which was the first of its kind) was subject to various sources of error, some of which have now been removed by better mechanical arrangements, and a few of which remain to be overcome. It will also be observed from the second part of the table that in April, 1876, after certain of these mechanical difficulties had been overcome, the percentage of error was much reduced, so that a sounding by the instrument and one by the line agreed on the average to within about *four per cent.* Dr. Siemens is now engaged in incorporating some improvements into a new instrument of this kind, and in particular in substituting for the corrugated diaphragm, which supports the column of mercury, one made of steel which is sawed through in a spiral form and covered by a sheet of India rubber.

In the trial of this first bathometer, Dr. Siemens took it to the top of the great clock-tower of the Houses of Parliament (315 feet), and it was found to read very closely what theory demanded. It may be reasonably hoped that the mechanical difficulties, which are very great, can be so far overcome as to cause the instrument to be read in the open sea within one or two per cent. of the true depth on the average. It must be remembered that the piano-wire apparatus gives the depth of water immediately below the ship, while the bathometer gives an indication of an attraction (or of a deficiency) which is the result of the depth of water for several miles in every direction. It gives the mean depth over a certain area.

A difficulty will always arise in the use of this device as a *navigating* instrument in general, as on approaching close to the land it will give an indication due not only to the depth of water beneath the ship, but partially due to the height of the neighboring land above the level of the sea. Thus we may expect to find *always* a reading of the instrument near the shore which will be different from what it would give in the open sea over the same depth of water, and hence, for general cruising, such an instrument will be an uncertain guide of a close approach to land. When, however, the water shoals gradually, so that the 100-fathom line is twenty-five to forty miles from shore in which case the disturbing effect of the distant shore would be very small, it would indicate with great certainty the shoaling of the water, and a simple observation of the *rate* of shoaling could not fail to be of service to the navigator.

The foregoing objections would not apply, however, in a case where the instrument was placed on a packet-ship which was continually making the same voyage, as on one of the Atlantic steamers for example.

If whenever the ship's position was known the bathometer was read and the reading entered on the chart, and if after ten or twenty voyages a particular instrument was constantly seen to have the same reading when the ship was in a given position (as it undoubtedly would), it could not fail to be trusted as a warning and as an aid. By an experience of this kind a table of the bathometer readings which corresponded to particular positions could be made and thoroughly tested on such a vessel, which is constantly crossing in the same track, so that after a time the reading of this particular bathometer would become an important sign of nearing a coast.

In this way, with intelligent officers who would not fail to put the necessary tests to it, it may yet be deemed suitable to serve as an important aid to navigation. Its great use will be, for the present, on board of special surveying ships, to indicate not so much the actual and absolute depths as the *changes of depth*. If, for example, a ship is engaged in making soundings with a trustworthy apparatus on board, and if it is found that a given depth by the piano-wire always corresponds very nearly to the same reading of the instrument (as it would), and if this continues to be so, then a change in the reading of the bathometer would indicate to the commanding officer the passage over shoaler or deeper water, as the case might be, and it would show the necessity for a new sounding—a necessity which otherwise would be overlooked. In the hands of intelligent officers this instrument, which is now an experiment merely, may become of great value, and it is quite within reasonable expectations to hope for valuable aid from it in its perfected form.

It is understood that an instrument of this class will soon be in the possession of the Navy Department, and one has been proposed for use on H. M. S. *Fawn*, and upon the reports of the officers who will have it in charge a correct appreciation of its practical usefulness can be based.

WORK ACCOMPLISHED BY THE CHALLENGER.

The thoroughness of the equipment of the *Challenger*, the abilities of the several officers and assistants, and the favorable circumstances generally combined to render this expedition one of the most fortunate and successful of any on record. Indeed, it may well be considered as marking an epoch in the scientific history of the world.

The first important advance made by the *Challenger* on our previous knowledge of the deep seas was in the discovery of a vast extent of red clay on the floor of the ocean at profound depths, and the comparative absence of life there. This extends far into the South Atlantic, merging into gray ooze to the north, while to the south a remarkable deposit of silicious matter covers the Antarctic Sea floor. The small amount of carbonate of lime and large amount of alumina and oxide of iron contained in it render its formation extremely difficult to understand. An important deduction is made that while this formation is going on to an immense extent, with but little trace of organic life in the depths below, the sea above teems with a variety of animal forms, thus having an exact analogy in well-known terrestrial strata. The cause of the absence of organic remains, as suggested by Professor Thomson, lies in the large amount of carbonic-acid gas held in suspension by the sea at great depths, which acts as a solvent on the carbonate of lime, leaving only the decomposed residuum to increase the thickness of the sea bottom.

Another result of the *Challenger's* work has been to establish as general principles what was only known to exist in isolated instances, namely, the universal lowering of the temperature of the great seas with increasing depth.

Previous expeditions have shown that the fauna of the deep seas contained species, genera, and groups which existed during past ages, many of them being forms known only as fossils, thus surviving the various alterations that accompanied the geological periods. Numerous additional illustrations were found in connection with the expedition of the *Challenger*, which will doubtless in due time be brought forward.

In addition, however, the *Challenger* has shown that many of the species occur over very wide ranges in portions of the sea bottom far apart, especially those of great geological antiquity, forms being found in the New Zealand seas having a general resemblance to those at the same depth off Portugal and North Africa.

Some extremely curious forms of animal life were obtained by the *Challenger*, among them one crab that appeared to be all eyes, and another without any. The two remarkable sea-urchins obtained in the *Porcupine* expedition, *Salenia* and *Pourtalesia*, were found by the *Challenger*, the latter over a wide area. A great hydroid was found, as large as a young tree, and many sponges of exquisite beauty. The globigerina, under the careful examination of surface specimens, proved to have a spiny coat surrounding the holes, through which the contractile and motile yet structureless protoplasm protrudes.

The deepest Atlantic sounding was made nearly ninety miles north of St. Thomas, in 3875 fathoms; the deepest in the Pacific was about five degrees east of Jeddo, 3950 fathoms, with a bottom of red clay. In the Pacific there were some very important observations made in regard to the existence of confined basins at the sea bottom, having a uniform temperature for a considerable depth. The depth of these submarine basins was ascertained by noting the distance over which the same temperature was maintained. When the thermometer indicated a gradual lowering of temperature to a certain point, and then remained unchanged with increasing depth, it was concluded, with great show of reason, that the area was surrounded by a barrier without any opening through which the bottom waters could penetrate. No such basins were found in the Atlantic.—13 *A*, *June* 3, 1876, 538.

SWEDISH ARCTIC EXPLORATIONS TO 1875.

The Swedish government publishes in a small pamphlet a general account of Sweden, and a catalogue of the objects presented by the Swedish government for exhibition in the International Geographical Congress at Paris in 1875. In this volume we find noticed the following Swedish expeditions for the exploration of the arctic regions: In 1837

Professor Sven Loven began an expedition to Spitzbergen which continued until 1838, in which year the French government sent out a similar expedition, generally known as the Commission du Nord. In 1857 Torell explored Iceland, and in 1858 Nordenskjöld visited Spitzbergen. In 1859 Dr. Torell explored a portion of Greenland. In 1861 a government expedition left Tromsö for Spitzbergen, Dr. Torell being chief, with Nordenskjöld and others as his collaborators. In 1863 Dr. Quennerstadt undertook an expedition to the island of Jan-Mayen and the neighboring seas. In 1864 a third Swedish expedition was sent to Spitzbergen, Dr. Nordenskjöld being chief of the scientific corps. In 1865 Dr. Paijkull explored Iceland. In 1868 a fourth Swedish expedition was made to Spitzbergen, under the direction of Nordenskjöld and a considerable corps of scientists, in which expedition Beeren Island was visited. In 1870 Dr. Nordenskjöld undertook a voyage to Greenland, hoping to make use of Esquimau dogs for sledge journeys. The principal field of their explorations was the west coast of Greenland, between the 68th and 71st degrees of latitude. This expedition was very successful in the collection of large masses of meteoric iron. In the spring of 1871 an expedition to Greenland was made by a vessel of the Swedish Navy, under the command of Baron Von Otter. In 1872 an expedition intended to pass the winter at Spitzbergen was sent out, consisting of three vessels, under Palander and Crazensteon; and two other Swedish expeditions were also sent to Spitzbergen under private expense—one in 1870, with the object of exploring the phosphatic strata. The second expedition of 1872 was also urged in the same interest, but accomplished much for geology. Finally, the expedition of 1875 to Nova Zembla was carried out entirely at the expense of Oscar Dickson. It was under the scientific direction of the indefatigable Professor Nordenskjöld.

EXPLORATIONS MADE UNDER THE DIRECTION OF F. V. HAYDEN IN 1876.

For reasons beyond the control of the geologist in charge, the various parties comprising the United States Geological and Geographical Survey of the Territories did not commence their field work until August. Owing to Indian hostility, the labors of the Survey were confined to the completion of the Atlas of Colorado. Therefore the work of the season of 1876 was devoted to finishing the entire mountainous portion of Colorado, with a belt fifteen miles in width of Northern New Mexico, and a belt twenty-five miles in breadth of Eastern Utah. Six sheets of the Physical Atlas are now nearly ready to be issued from the press. Each sheet embraces an area of over 11,500 square miles, or a total of 70,000 square miles. The maps are constructed on a scale of four miles to one inch, with contours of 200 feet, which will form the basis on which will be represented the geology, etc.

The point of departure the past season was Cheyenne, Wyoming Territory.

The primary Triangulation party was placed in charge of A. D. Wilson, and took the field from Trinidad, the southern terminus of the Denver and Rio Grande Railway, August 18th, making the first station on Fisher's Peak. From this point the party marched by the valley of the Purgatoire, crossed the Sangre de Christo Range by way of Costillia Pass, and followed the west base of the range northward as far as Fort Garland, making a station on Culebra Peak. About six miles north of Fort Garland is located one of the highest and most rugged mountain-peaks in the West, called Blanca Peak, the principal summit of the Sierra Blanca group. On the morning of August 28th the party started to ascend this peak. They found no difficulty in riding to timber line, which is here about 12,000 feet above sea-level. Here they were compelled to leave the animals, and carry the instruments themselves. The main summit is about two miles north of the first point, in a straight line, and connected with it by a very sharp ridge, difficult to pass on account of the loose rocks and the constant fear of tumbling. After difficult climbing they found themselves on the summit. From here a magnificent view was spread out before them. A large portion of Colorado and New Mexico could be seen. This point is the highest in the Sierra Blanca group, and, as far as is known at the present time, is the highest in Colorado. The elevation was determined by Mr. Wilson. First a mean of eight barometric readings, taken synchronously with those at Fort Garland, gave a difference between the two points of 6466 feet; secondly by fore and back angles of elevation and depression, which gave a difference of 6468 feet. The elevation at the Fort was determined by a series of readings compared with the Signal Service barometer at Colorado Springs, giving an elevation of 7997 feet, making Blanca Peak 14,464 feet above sea-level. This peak may be regarded therefore as one of the highest in the United States. A comparison with some of the first-class peaks in Colorado will show the relative height:

		Feet.
Blanca Peak	above sea-level	14,464
Mount Harvard	" " "	14,384
Gray's Peak	" " "	14,341
Mount Lincoln	" " "	14,296
Mount Wilson	" " "	14,280
Long's Peak	" " "	14,271
Uncompahgre Peak	" " "	14,235
Pike's Peak	" " "	14,146

The foregoing table will afford some conception of the difficulty encountered in determining the highest peak, when so many occur that are nearly of the same elevation. About fifty peaks are found within the limits of Colorado that exceed 14,000 feet above sea-level.

From this point the party proceeded westward across the San Luis Valley and up the Rio Grande to its source. From the head of the Rio Grande the party crossed the continental divide, striking the Animas Park, thence by trail to Parrott City.

After making a station on La Plata Peak, the party marched northwest across the broken Mésa country west of the Dolores, making three stations on the route. After making a primary station on the highest point of the Abajo Mountains, the party turned westward to Lone Cone; thence crossing the Gunnison and Grand Rivers, they proceeded to the great volcanic plateau at the head of the White River. The final station was made between the White and Yampah Rivers in the northwestern corner of Colorado. During this brief season Mr. Wilson finished about 1000 miles of topography and made eleven geodetic stations, thus connecting the whole of Southern and Western Colorado.

In company with the Triangulation party, Mr. Holmes made a hurried trip through Colorado, touching also portions of

New Mexico and Utah. He was unable to pay much attention to detailed work, but had an excellent opportunity of taking a general view of the two great plain belts that lie—the one along the east, the other along the west base of the Rocky Mountains. For nearly 2000 miles' travel he had constantly in view the cretaceous and tertiary formations, among which are involved some of the most interesting geological questions. He observed, among other things, the great persistency of the various groups of rocks throughout the east, west, and north, and especially, in the west, that from Northern New Mexico to Southern Wyoming the various members of the cretaceous lie in almost unbroken belts, while the tertiaries are hardly less easily followed.

Between the east and the west there is only one great incongruity. Along the east base of the mountains the upper Cretaceous rocks, including Nos. 4 and 5, are almost wanting, consisting at most of a few hundred feet of shales and laminated sandstones. Along the west base this group becomes a prominent and important topographical as well as geological feature. In the northwest, where it forms the "Mésa Verdé," and the cap of the Dolores plateau, it comprises upward of 2000 feet of coal-bearing strata, chiefly sandstone, while in the north it reaches a thickness of 3500 feet, and forms the gigantic hog-back of the Grand River Valley.

While in the southwest he visited the Sierra Abajo, a small group of mountains which lie in Eastern Utah, and found, as he had previously surmised, that the structure was identical with that of the four other isolated groups that lie in the same region. A mass of trachyte has been forced up through fissures in the sedimentary rocks, and now rests chiefly upon the sandstones and shales of the lower Cretaceous. There is a considerable amount of arching of the sedimentary rocks, caused probably by the intrusion of wedge-like sheets of trachyte, while the broken edges of the beds are frequently bent abruptly up as if by the upward or lateral pressure of the rising mass. He was able to make many additional observations on the geology of the San Juan region, and secured much valuable material for the coloring of the final map.

He states that the northern limit of the ancient cliff builders in Colorado and Eastern Utah is hardly above latitude 37° 45′.

The Grand River Division was directed by Mr. Henry Gannett, topographer, with Dr. A. C. Peale as geologist. Mr. James Stevenson, executive officer of the Survey, accompanied this division for the purpose of assisting in the management of the Indians, who last year prevented the completion of the work in this locality by their hostility.

The greater portion of the work of this division lay north of the Grand River, limited on the north by the parallel of 39° 30′, and included between the meridians of 108° and 109° 30′.

This division took the field at Cañon City, Colorado, about the middle of August. The party traveled nearly west, up the Arkansas River, over Marshall's Pass, and down the Tomichi and Gunnison Rivers to the Uncompahgre (Ute) Indian Agency. Here they secured the services of several Indians as escort in the somewhat dangerous country which they were first to survey. This area lying south of the Sierra La Sal was worked without difficulty. It is a broken plateau country, and presents many curious pieces of topography. Eleven days were occupied in this work.

The Grand River, from the mouth of the Gunnison to that of the Dolores, *i. e.*, for nearly a hundred miles, flows along the southern edge of a broad valley, much of the way being in a low cañon, one hundred to two hundred feet deep. The course of the river is first northwest for twenty-five miles, then, turning abruptly, it flows southwest, and then south for about seventy-five miles. This valley has an average width of twelve miles. It is limited on the north and west by the Roan, or Book Cliffs, and their foot-hills, which follow the general course of the river. These cliffs rise from the valley in a succession of steps to a height of about 4000 feet above it, or 8000 to 8500 above the sea.

From its crest, this plateau (for the Book Cliffs are but the southern escarpment of a plateau) slopes to the N.N.E. at an angle of not more than 5°. It extends from the Wahsatch Mountains on the west to the foot-hills of the Park Range on the east, and presents every where the same characteristics. The Green River crosses it, flowing in a direction exactly the reverse of the dip. It borders the Grand on the north for one hundred and fifty miles, the east forming the divide between the Grand and the White. On the south side of the crest are broken cliffs; on the north side, the branches of the White cañon immediately. This leaves the divide in many places very narrow, in some cases not more than thirty to forty feet wide, with a vertical descent on the south toward the Grand River, and an extremely steep earth slope (35° in many cases) at the heads of the streams flowing north to the White River. This crest, though not over 8500 feet in height, is the highest land for a long distance in every direction.

After leaving the Uncompahgre Agency, the party followed Gunnison's Salt Lake road to the Grand, and down that river to the mouth of the Dolores, in latitude 38° 50′, longitude 109° 17′. At this point they turned northward, and went up to the crest of the Book Plateau. They followed this crest to the eastward for upward of a hundred miles to longitude 108° 15′, and thence *via* the White River (Ute) Indian Agency to Rawlins, where they arrived on October 23d.

The whole area worked is about 3500 square miles, in surveying which about sixty stations were made.

The geological work of this division, by Dr. Peale, connects directly with that done by him in 1874 and 1875. Sedimentary formations prevail on both districts visited the past season.

The country first examined lies between the San Miguel and Dolores Rivers, extending northward and northwestward from Lone Cone Mountain. The general character of this region is that of a plateau cut by deep gorges or cañons, some of which, especially toward the north, extend from the sandstones of the Dakota group to the top of the red beds. The depth of the cañon, however, is no indication of its importance as a stream-bed, for away from the main streams they are dry the greater portion of the year. There are not great disturbances of the strata, what folds do occur being broad and comparatively gentle.

The San Miguel River, leaving the San Juan Mountains, flows toward the northwest, and with its tributaries cuts through the sandstones of the Dakota group, exposing the variegated beds lying beneath, that have generally been referred to the Jurassic. About 25 or 30 miles north of Lone Cone the river turns abruptly toward the west, and flows west and southwest for about 15 miles, when it again turns, and flows generally northwest until it joins the Dolores. Between the San Miguel and Lone Cone, the sandstones of the Dakota group (or No. 1 cretaceous) are nearly horizontal, forming a plateau which, on approaching the mountains, has a capping of cretaceous shales.

Beyond the bend, the San Miguel flows in a monoclinal valley, in which the cañon walls are of the same description as in the upper part of its course. As the mouth is approached the red beds appear. Between this portion of the course of the San Miguel and the almost parallel course of the Dolores, which is in a similar monoclinal rift, there are two anticlinal and two synclinal valleys parallel to each other. They are all occupied by branches of the Dolores. Lower Cretaceous, Jurassic, and Triassic strata outcrop, and present some interesting geological details, which will be fully considered in the report on the district. The Dolores River comes from a high plateau in a zigzag course, flowing sometimes with the strike and sometimes with the dip of the strata. Its general course on the western line is about northwest, from which it turns to the northward and westward, finally changing to northwest again to its junction with the Grand. It is in cañon the greater part of its course. In the region of country north of Grand River the geological formations extend uninterruptedly from the red beds exposed on Grand River to the white tertiary cliffs forming the summit of the "Roan Mountains," or Book Cliffs. The Grand is generally in a cañon in the red beds.

On the north side the No. 1 cretaceous sandstone forms a hog-back sloping toward the cliffs. Between the crest of this hog-back and the cliffs there is a broad valley formed by the erosion of the soft cretaceous shales which extend to the base of the cliffs, and in some places form their lower portion. The cliffs are composed mainly of cretaceous beds, rising one above another in steps, until an elevation of about 8000 feet is reached. The summit is the edge of a plateau sloping N.N.E. This plateau is cut by the drainage flowing into the White River from the south. These streams rarely cut through the tertiary series.

Coal of poor quality is found in the sandstones of the Dakota group, and also in the sandstones above the middle cretaceous beds. Wherever noticed, it was in thin seams and of little economic importance.

The White River Division was directed by G. B. Chittenden as topographer, accompanied by F. M. Endlich as geologist.

The district assigned to this party as their field for exploration during the season of 1876 commenced from the eastward at longitude 107° 30′, joining on to the work previously done, and extended westward 30 miles into Utah Territory. Its southern boundary was north latitude 39° 30′, while the White River formed the northern limit. In order to take the greatest possible advantage of the short time that could be allowed, it was determined to make the White River Agency the head-quarters, and in two trips from there complete the work. About 3800 square miles comprised the area surveyed.

In working up the topography of the district, the party spent 48 days of absolute field-work, made 41 main topographical stations and 16 auxiliary ones, and traveled within the district about 1000 miles. The party ascertained the course of all the main trails, the location and quality of nearly all the water—which is scanty throughout—and can map with considerable accuracy the topographical forms and all the water-courses. The area is almost entirely devoid of topographical "points," and the topographer is obliged to depend to a considerable degree on those far to the north and south for the triangulation. The country has been heretofore almost entirely unexplored, and was described by the nearest settlers as a broken cañon country, extremely dry. It was marked on the maps as a high undulating plateau, with fresh-water lakes and timber. The party saw no lakes of more than four hundred yards in diameter, and only two or three of those. The country is nearly all inhabitable both winter and summer, and considerable portions of it valuable, and, though three quarters of it is within the Ute Indian Reservation, the advantage of a more accurate knowledge of its character can readily be seen.

Altitudes were determined by the mercurial barometer, with a base at the White River Indian Agency, and checked by a continuous system of vertical angles. The altitude of the Agency has been determined by a series of barometric observations extending over two years and a half, and referred to railroad levels, and can probably be depended on to within a few feet.

The general topography is a gentle rise from the White River toward the south, and a sudden breaking off, when the divide is reached, into ragged and often impassable cliffs, known on the maps as the Roan or Book Mountains. The gentle plateau slope of the White River side is cut by almost numberless and often deep cañons, and in many cases the surface of the country has been eroded away, leaving broken and picturesque forms, the lower benches generally covered with cedars and piñons, and the upper rich in grass.

There are four main streams draining into the White River within the limits of our work—a distance of something over 100 miles. All of these streams have more or less good water at their heads. They traveled nearly the whole length of all these water-courses, but found good trails only in the middle ones. Trails, which traverse the whole district in every possible direction, keep mostly on the summit of the ridges and plateaus, and, by taking care not to cross the cañons, the country is very easily traveled through.

The country is almost entirely destitute of timber, and has but little good water. It is, however, abundantly supplied with grass, and, especially in the winter season, must be well stocked with game.

In the far western portion, and outside the limits of the Reservation, one large vein of asphaltum and several small veins were found, and also running springs of the same material—all of which, if once reached by railroad, will prove of great commercial value. These deposits have been spoken of before, but their location has not been accurately determined.

According to the report of F. M. Endlich, the geology of the district is very simple, though interesting. Inasmuch as but one divide of importance occurred within the district, the work was somewhat simplified. This was formed by the Book Cliffs—between the drainages of the Grand on the south and the White on the north. Both of these rivers flow a little south of west into the Green River, which they join in Utah. From the junction of the Grand and Green downward, the river is called the Great Colorado. Orographically the region surveyed is comparatively simple. The Book Cliffs are the summit of a plateau about 8000 feet above sea-level, continuing unbroken over to the Green River. Toward the south these cliffs fall off very steeply, forming deep cañons that contain tributaries of the Grand River. On the north side, with the dip of the strata, the slope is more gentle, although in consequence of erosion numerous precipitous cliffs are found. Descending in that direction, the character of the country changes. Instead of an unbroken slope, we find that the plateau has been cut in parallel directions by the White River drainage, and the long characteristic mésas of that region testify to the character of erosion. Approaching the river, constantly descending with the slight dip of the strata, the bluffs become lower and lower. Though the creek valleys are wide, and at certain seasons no doubt well watered, the vegetation is that of an arid country. Dwarf pines, piñons, and sage-brush abound, to the almost entire exclusion of other trees or grass. Traveling down White River, this character is again found to change. A new series of bluffs, occasioned by heavy superincumbent strata, gives rise to the formation of deep cañons.

For 45 miles the party followed the cañon of the White, which, no doubt, is analogous to that of the Green, and probably closely resembles that of the Colorado in its detail features. Vertical walls inclose the narrow river-bottoms, and the slopes of the higher portions are ornamented by thousands of curiously eroded rocks. Monuments of all kinds, and figures that can be readily compared to those of animated beings, enliven the scenery, which otherwise would be very monotonous. Two to three thousand feet may be stated as the height of the walls inclosing the White River.

Geologically speaking, the district was one of singular uniformity. Traveling westward, the older formations, reaching back as far as the Jurassic, were found. This was followed by cretaceous, which in turn was covered by tertiary. About three quarters of the region surveyed was found to contain beds belonging to this period.

Owing to the lithographical character of the strata, water was a rare luxury in this region, and men and animals were frequently dependent upon finding springs.

Farther west still the Green River group sets in, forming those numerous cañons of which that of the White River is one. Having completed their work by October 14th, the party marched eastward through Middle Park, and, after twelve days of rain and snow, reached Boulder City, Colorado.

The field-work of the Yampah Division during the past season was principally confined to a district of Northwestern Colorado lying between the Yampah and White Rivers, and between Green River and the subordinate range of mountains that lies west of and parallel with the Park Range. The area is embraced between parallels 29° 30′ and 40° 20′, and meridians 107° 30′ and 109° 20′.

The party consisted of Mr. G. R. Bechler, topographer directing, accompanied by Dr. C. A. White, the well-known geologist. They proceeded southward from Rawlin's Springs, a station on the Union Pacific Railroad, August 6th, toward their field of labor. From Rawlin's Springs to Snake River, a distance of eighty miles, table-lands form the chief feature of the topography; while from Snake River to the Yampah River the distance is more undulating, and thickly covered with sage. Between the Yampah and White Rivers, a distance of fifty miles, the country is mountainous; and on the divide between the Yampah and White Rivers the elevation is 8000 to 9000 feet. Mr. Bechler, after having formed the geodetic connection with the work of previous years, concluded to finish the more mountainous portion of the area assigned to him, which began from a line of meridian with the White River Agency, and extended westward to about 108° 10′. Here the party found water and grass in abundance, with one exception. The plateau country, however, was so destitute of water, and so cut up with dry gorges or cañons, with scarcely any grass or timber of any kind, that traveling was rendered very difficult. The party, therefore, made White River its base of supply for water and grass, making side trips into the barren hill-tops or plateaus in every direction.

From the Ute Agency, which is located approximately in lat. 38° 58′ and long. 107° 48′, the White River takes an almost due west course for fifteen or eighteen miles, most of the way through an open valley, with here and there narrow gorges. About fifty miles from the Agency the river opens into a broad, barren valley, with only here and there scanty patches of vegetation. Soon after it enters a deep cañon with vertical walls, 1000 feet or more in height, and continues to increase in depth until its junction with the Colorado River of the West. The Yampah or Bear River deviates from a westerly course only for a few miles occasionally. Like White River, it flows through a plateau country which rises gently from the river, back for a distance of about eight miles. South of the river lie the Williams River Mountains, which have a gradual slope to the north. Williams Fork, flowing from a southeastern direction, joins the Yampah River. West of the junction, the Yampah traverses the country more or less in a cañon, cuts through the Yampah Mountains, when it joins with the Snake River. The place of junction resembles a fine park, surrounded on all sides with eroded terraces and plateau spurs, that rise by steps to the divide on either side. This park is about eight miles in length from east to west.

After leaving this park, the river enters a huge fissure in the mountains, where it remains until, completing its zigzag course, it joins the Green River in lat. 32° and long. 109° 40′. After the junction with the Yampah, the Green River continues in a cañon for fourteen miles, when it passes through the picturesque palisades of Split Mountain into an open, broad valley (lat. 40° 28′, long. 109° 15′), from which point it takes a southeastern direction through the Wamsitta Valley, where it unites with the White River.

Into both the White and Yampah Rivers numerous branches extend from either side, forming deep cañons the greater portion of their length. We may say, in brief, that the sides of the valleys expand and contract, at one time forming the beautiful grassy valleys which in olden times were celebrated as the favorite wintering-places for the trappers, or contracting so as to form narrow cañons or gorges with walls of varied height.

The walls of Yampah Cañon average about 1000 feet, while the mountains, receding to the northward, attain an elevation of 4200 feet, the highest point of the plateau on the south side being 3400 feet above the river level.

Of the plateaus between the White and Yampah Rivers, Yampah Plateau is the largest, and occupies an area of 400 square miles. The surface of the summit is undulating, presenting on the south side a steep face, several hundred feet in height, covered with *débris*, rendering it almost inaccessible. This plateau is covered with excellent grass, and gives origin to numerous springs, all of which dry up within a short distance of their source. As a whole, this district is very arid, and almost destitute of tree vegetation.

The total number of stations made by Mr. Bechler, in the district assigned to him, was forty, and the entire area about 3000 square miles. Barometric observations were made whenever needed, and about 2000 angles of elevation and depression with fore and back sights, so that the material for obtaining the correct altitudes is abundant.

The rocks of this district embrace all the sedimentary formations yet recognized by the investigators who have studied the region that lies between the Park Range and the Great Salt Lake, namely, from the Uintah quartzite (which underlies the carboniferous) to the group or latest tertiary, inclusive. Not only have the geographical distributions of these formations been mapped, but all the displacements of the strata have been traced and delineated, the latest-named investigations bringing out some interesting and important facts in relation to the orographic geology of the region, especially as regards the eastern termination of the great Uintah uplift, and the blending of its vanishing primary and accessory displacements with those of the north and south range above mentioned. Much information was also obtained concerning the distribution of the local drift of that region, the extent and geological date of outflow of trap, etc.

The brackish water-beds at the base of the tertiary series containing the characteristic fossils were discovered in the valley of the Yampah. They are thus shown to be exactly equivalent with those now so well known in the valley of Bitter Creek, Wyoming Territory. These last-named localities were also visited at the close of the season's work, and from the strata of this horizon at Black Buttes station three new species of *Unio* were obtained, making six clearly distinct species in all that have been obtained, associated together in one stratum, at that locality. They are all of either distinctively American types or closely related to species now living in American fresh waters. They represent, by their affinities, the following living species: *Unio clavus*, Lamarck; *U. securus*, Lea; *U. gibbosus*, Barnes; *U. metaneorus*, Rafinesgue; and *U. complanatus solander*. They are associated in the same stratum with species of the genera *Corbula*, *Corbicula neritina*, *Viriparus*, etc., and which stratum alternates with layers containing *Astrea* and *Anomia*.

The close affinity of these fossil *Unios* with species now living in the Mississippi River and its tributaries seems plainly suggestive of the fact that they represent the ancestry of the living ones. An interesting series of facts has also been collected, showing that some of the so-called American types of Unio were introduced, in what is now the great Rocky Mountain region, as early as the Jurassic period, and that their differentiation had become great and clearly defined as early as late cretaceous and early tertiary times. Other observations present the probable lines of geographical distribution, during the late geological periods, of their evolutional descent, by one or more of which they have probably reached the Mississippi system, and culminated in the numerous and diverse forms that now exist there.

The work of the past season shows very clearly the harmonious relations of the various groups of strata over vast areas; that, although there may be a thickening or thinning out of beds at different points, they can all be correlated from the Missouri River to the Sierra Nevada basin. The fact also that there is no physical or paleontological break in these groups over large areas from the cretaceous to the middle tertiary is fully established. The transition from marine to brackish-water forms of life commences at the close of the cretaceous epoch, and, without any line of separation that can yet be detected, continues on upward until only purely fresh-water forms are to be found. Dr. White, an eminent paleontologist and geologist, says that the line must be drawn somewhere between the cretaceous and tertiary epochs, but that it will be strictly arbitrary, as there is no physical break to the summit of the Bridger group.

EXPLORATION OF THE ROCKY MOUNTAIN REGION, BY J. W. POWELL.

As soon as the appropriation for the fiscal year of 1876–77 could be used, the surveying corps left Washington and proceeded to the rendezvous camp at Gunnison, Utah Territory, where the field parties were organized under the general superintendence of Professor A. H. Thompson, geographer of the expedition. While *en route* they were joined by Captain Clarence E. Dutton, of the Ordnance Department U. S. A., who had been assigned by special orders from the Secretary of War for duty with this survey, and directed to make an examination of the immense fields of igneous rocks in Southeastern Utah.

The field organization as finally completed differed somewhat from previous years—the geographic and geological work being assigned to separate parties, each practically independent in all movements, though working under the same general plan and within the same territorial limits. It is believed that better results can be and have been secured by this separation of distinct branches of the survey than by the old method of attaching a geologist to a geographic party, or a geographer to a geological party.

Five parties were organized: one, under Professor A. H. Thompson, to continue the triangulation; one topographic party under Mr. Walter H. Graves, another under Mr. John H. Renshaw; one geological party under Mr. G. K. Gilbert, another under Captain C. E. Dutton.

The party under Professor Thompson continued the expansion of the primary triangulation, resting on the base-lines measured in preceding years at Kanab and Gunnison, Utah. The area embraced in this season's work amounts to about 10,000 square miles, the instrument used being a 10-inch theodolite of peculiar construction, designed especially for this work by Professor Thompson.

Topographic party No. 1, under the charge of Mr. Graves, extended the secondary triangulation over an area of 6000 square miles, lying between the Wahsatch Mountains on the west and the Green and Colorado Rivers on the east. Mr. Graves also made a complete plane-table sketch of the country surveyed, which, taken in connection with his angles for location and perspective profile sketches, will enable him to construct a map of his district on a scale of four miles to the inch. The principal topographic characteristics of this region are long lines of unscalable cliffs, which are the escarped edges of terraced plateaus of which the country is composed, and deep, narrow cañons with vertical walls, both presenting well-nigh impassable barriers to travel. The only considerable bodies of irrigable lands found are along the valleys of the Green and San Rafael Rivers. The only timber lands are on the Sevier plateau, at an elevation of from 8000 to 11,500 feet.

The work of topographic party No. 2, under Mr. Renshaw, was confined to Southwestern Utah and Southeastern Nevada, one of the most rugged and barren sections in the Great Basin. The methods of survey were the same as those adopted by party No. 1, except that perspective profile sketches were made by the aid of the orograph, a newly designed instrument that promises to be of great use in topographic surveying. The work of Mr. Renshaw and his able assistant, Mr. O. D. Wheeler, was extended over about 4000 square miles. In all this area no considerable bodies of irrigable lands are found—probably not one half of one per cent. possessing any value except for pasturage.

A topographic survey of the Henry Mountains was made in 1875, and a map constructed on a scale of four miles to the inch; but this being thought too small a scale to admit of correct representation of the details of the geology, Professor Gilbert, in addition to his geological work, made a more detailed survey of the topography, carrying a complete system of secondary triangulation, and a connected plane-table sketch, over more than 1000 square miles. The data collected are sufficient to make a topographic map of the Henry Mountains on the scale of two miles to the inch, or $\frac{1}{63000}$.

The Rocky Mountain region of the United States (not including Alaska), or that portion west of the meridian of 99° 30′, was by a former Secretary of the Interior divided into districts for surveying and mapping purposes, and these districts numbered; the area of each district is 2½° in longitude, 1¼° in latitude. The region of country surveyed by the parties under the direction of Professor Powell is embraced in districts numbered 75, 85, 86, 95, 96, 104, and 105, the first five lying directly west of the region in which Dr. Hayden is engaged, while districts 104 and 105 lie immediately south of the other districts in which he himself has been at work. During the earlier part of his work, before these districts were established by the Department, Professor Powell's work extended in an oblique direction from northeast to southwest along the general course of the Green and Colorado Rivers through the districts above designated, but the work was in such condition that no one district was complete. During the present season his parties have been engaged in extending the survey over the unsurveyed fractional districts, so that final and complete maps of each may be constructed.

The methods of survey during the present season are essentially the same as those employed during the last, being modified to a slight extent as experience has suggested; the chief improvements being in the method of triangulation. In addition to the determination of geodetic positions and general geographic features, the system of classifying the lands inaugurated in former years has been continued during the present, the object of this classification being to determine the extent and position of the irrigable lands, timber lands, grass lands, mineral lands, and waste lands—the latter being composed of rugged mountains and desert plains. The practical importance of this classification, if carefully made, is great, not only in presenting the information desirable to those who wish to settle in the country, but also in the collection of facts necessary to intelligent legislation concerning these lands.

In the region embraced in this survey, a very small portion of the country can be redeemed by irrigation for agriculture, and no part of it can be cultivated without irrigation. It appears from the reports that less than one per cent. can thus be made available. Especial care has been given to the determination of the extent of such lands, so as to exhibit their position on the maps. These irrigable lands and timber lands, together with some small districts of coal-bearing lands, are the only parts of the country that should be surveyed into townships and sections.

Having in view economy and convenience in the linear surveys of this district, the geodetic points of the general geographic survey, under the direction of Professor Powell, have been carefully marked, that they may hereafter be used as datum points by the officers of the General Land Office.

Extensive coal-fields exist in the region surveyed, but, as in many other parts of the world, these coal-fields are of practical value only at comparatively few places. The general characteristics of these coal-fields have been the subject of much investigation, and some very interesting and valuable results have been reached. These will appear in the final reports. The quantity of available coal is practically inexhaustible, and the mines that can be economically worked are of great number.

In the Uintah Mountains silver and copper mines have been discovered, and worked by private parties. The extent of these silver and copper bearing rocks has been determined, but their value can be established only by extensive working.

Mr. G. K. Gilbert devoted much of his time to the study of the structure of the Henry Mountains, of which enough had been learned in the preceding season to warrant the belief that they embodied a type of eruption hitherto unknown. The attention given to them has been amply repaid by the elucidation of the manner of their constitution. They are volcanic; but their lavas, instead of finding vent at the surface of the ground, and piling up conical mountains thereupon in the usual manner, ceased to rise while still several thousands of feet underground, and lifted the superincumbent strata, so as to make for themselves deep-seated subterranean reservoirs, within which they congealed. Over each of these reservoirs the strata were arched, and a hill or mountain was lifted equal in magnitude to that which would have been formed if the lava had risen to the surface; but the material of the hill was sandstone and shale, instead of hard volcanic rock. Subsequent erosion has carried away more or less completely the arching strata, and laid bare many of the volcanic masses. It has revealed also a system of reticulating dikes, which go forth in all directions from the main masses, intersecting the sedimentary rocks. The lava masses, the dikes, and those portions of shale and sandstone which have been metamorphosed by contact with the molten rock, are harder than the unaltered sedimentary strata which surround them, and yield to the agents of erosion more slowly. The wash of rain and streams by which the face of the surrounding land has been degraded, has been resisted by these hard cores, and in virtue of their obduracy we have the Henry Mountains. The deposits of lava are not all in juxtaposition, but are scattered in clusters, and each cluster has created a mountain. Mount Ellen is constituted by a score of individual lava-masses; Mount Pennell and Mount Hillers each by one chief mass, accompanied by several of minor importance; Mount Holmes by two masses; Mount Ellsworth by a single one, with many dikes and sheets. Each of the mountains is an individual, topographically as well as structurally, and together they constitute a group of mountains, not a range. Mr. Gilbert's note-books contain many sketches, by the aid of which he will be able to illustrate all the features of the peculiar types of structure.

Before commencing the main work of the season, Mr. Gilbert made an excursion in search of the outlet of Lake Bonneville, the great fossil lake of Utah. During an epoch which was probably coincident with the glacial epoch, the broad interior basin of Utah was covered by a great lake, which overflowed its rim, and sent an outlet to the ocean by way of the Columbia River. When the climate became gradually warmer and dryer, the evaporation grew greater and the rainfall grew less, until finally the overflow ceased, and the lake began to dry away and shrink within its shores; today only Great Salt Lake and Sevier Lake remain, but high up on the mountain is carved the Bonneville beach, a permanent record of the old flood tide. The search for the point of outlet was successful, and it was found at the north end of Cache Valley, a few miles beyond the boundary of Utah, in the territory of Idaho. The bed of the outflowing stream was traced for a number of miles. The beach lines were seen to run quite to the pass through which the channel was cut, but beyond, on the side of the drainage of the Columbia, no trace of them could be seen.

Of no less interest was the discovery of a recent orographic movement at the western base of the Wahsatch Range. A great fault runs along that base—one of the faults by which the mountain was produced. The block of the earth's crust which lies to the westward of the fault-plane was dropped down, and the block which lies to the eastward was lifted up, and from the eastward block subsequent erosion has carved the range. Along this plane of ancient movement there has been a recent movement. The mountain has risen a little higher or the valley-floor has dropped a little lower, and this so recently that the Bonneville flood is ancient in comparison.

Captain C. E. Dutton resumed this year his study of the large area of igneous rocks in Southern Utah, in the vicinity of the Sevier River, and has brought back additional information, which he purposes employing in the preparation of a monograph of the entire track. He has worked out the structure of the component features and the approximate age of the eruptions, and is engaged in classifying the various lithologic members. The older outbreaks appear to be of early tertiary age (eocene), and to have been nearly continuous through a long period. The volcanic beds thus formed were subsequently traversed by great faults, and tables were uplifted with deep valleys between them; the structure thus produced conforming to the general type prevalent throughout the plateau country. The degradation of these lofty tables gave rise to conglomerate beds of great extent and thickness, which are composed entirely of volcanic materials. Captain Dutton has compared the details and arrangement of these conglomerates with the alluvial beds now accumulating in great volume in the valleys out of the waste of the adjoining tables, and finds an agreement between them so close that he ascribes the same mode of origin to both. He also finds considerable metamorphism, not only in the underlying sedimentary beds (early tertiary), but in the superposed conglomerate, and which he thinks must have occurred comparatively near the surface. The greater portion by far of the erupted rocks he classes as trachytes and trachy-dolerites. The rhyolitic varieties are of very limited occurrence, being found only in the vicinity of the Beaver or Tushar Range. In the southwestern part of the field (near Sangquitch) extensive fields of basalt are found. Captain Dutton distinguishes two ages of the basalt, one prior to the development of the present structural features of the region, the other subsequent to it—the former being more properly dolerite or anamesite, the latter typical basalt.

Under instructions from the Interior Department, Professor Powell and his parties have also been engaged in general ethnographic work in the Rocky Mountain region. One of the special items in these instructions was the classification of the Indian tribes, such classification being not only of scientific interest, but of great importance in the administration of Indian affairs. For the eastern portion of the United States this work had been accomplished, first, by the unofficial labors of the Hon. Albert Gallatin, and subsequently by the Hon. Henry R. Schoolcraft, as an officer of the government; and some additions had been made to this work by various persons for scientific purposes. This work has been renewed by Professor Powell, and has been pushed with all the energy possible with the funds at his command, and a large amount of material has been collected by himself and by members of his corps, and by residents in and travelers through the country. In addition to this, a large amount has been collected by the Smithsonian Institution through various channels—materials as yet unpublished. The officers of that Institution have placed all this matter in the hands of Professor Powell, to be combined with his own collections. In the preparation of the results of these collections for publication, he has the assistance of J. Hammond Trumbull, Professor F. L. O. Roehrig, and Mr. W. H. Dall. The first volume of the reports on this subject will soon be issued. It treats of the tribes of Alaska, the western half of Washington Territory, and Northwestern Oregon, and is accompanied by maps exhibiting the geographic distribution of the tribes of these regions. A second volume, on the tribes of California, has also been sent to the government printer, which will be succeeded by others as rapidly as they can be prepared.

Dr. Elliott Coues, U. S. A., is engaged on a "Report on the Birds of the Valley of the Colorado," based primarily on the collections made by the several parties under Professor Powell's direction. This report was sent to the government printer early in the spring, and about 200 pages have already been set up.

Mr. L. F. Ward, the botanist of the corps, assisted by several gentlemen of scientific ability in this department, has been engaged during the entire year in the preparation of a "Report on the Botany of the Valley of the Colorado," which is now nearly ready for publication.

EXPLORATIONS IN 1876 OF LIEUT. GEORGE M. WHEELER, U. S. E.

The expedition of 1876 was delayed in its departure for the field because of the lateness of action by Congress in making appropriations. Six parties were, however, organized and placed in the field for the full season, and a seventh for a part of the season, until the near approach of winter necessitated the termination of the field-work about December 1st. The work of the year was, as in 1875, divided into two sections, designated as the California and Colorado sections, the work being limited to areas in California, Nevada, Colorado, and New Mexico. In the special branches of Natural History the number of scientific observers was unavoidably reduced from the limited appropriations of money which were available.

The year marks a gratifying improvement in the grade of the geodetic and topographic work, one of the features being the collection of materials for a detailed topographical map of Lake Tahoe and the surrounding Sierra Nevada region on a scale of one inch to a mile; and of the section embracing the famous Comstock lode and its surroundings upon a scale of one inch to 500 feet. This implies no departure from the original plan of confining the general topography in the more sparsely settled regions to the amount necessary for the construction of a map on a scale of one inch to eight miles, or $\frac{1}{506880}$.

The astronomical stations occupied in 1873 by parties of this survey on the divide between Virginia City and Gold Hill, Nevada, were connected this season with the extremities of a base-line, more than four miles long, measured in the valley of the Carson River. Triangles developed from this base form the basis of the system of triangles extended over the entire area.

Main astronomical stations, with the adjacent measured bases, had been determined along the east face of the Rocky Mountains from Hughes, Colorado, on the north, to Las Vegas and Santa Fé, New Mexico, on the south, and the scheme of triangulation already begun was farther carried out.

A noteworthy feature of the past season's work is the greater attention paid to the determination of the boundaries of areas of marked natural resources, such as those valuable for agriculture, with or without irrigation, for grazing, for timber, and for mines, as contrasted with the arid or absolutely sterile parts. The outgrowth of this system will be the preparation for the use of the government of a series of charts indicating, with a close approximation, the nature of the surface as found, and its consequent adaptability to the various industries.

A small office force has been constantly employed in constructing the maps for the finished atlas from the large amount of original material already collected.

The San Juan mining region of Southwestern Colorado has been delineated upon a scale of one inch to two miles, and shows effectively the peculiar mountain structure of this wonderful region, in which nestle the heads of seven large streams—the Rio Grande, the Lake Fork of the Gunnison, the Uncompahgre, the Unanup, the San Miguel, the Dolores, the Mancos, and the Las Animas Rivers.

During the year Vol. V. (Zoology) of the 4to Reports has been issued, containing 1023 pages, with forty-five plates and three wood-cuts.

A catalogue of the mean declination of 2018 stars, used for the determination of latitude by the zenith telescope, by Professor T. H. Safford, is passing through the press, and a volume by Professor Cope upon the Vertebrate Paleontology of portions of New Mexico is soon to be issued. The regular Annual Report of the Survey for 1876 is accompanied by seven atlas sheets, and has, in addition to the usual matter, several papers on subjects relating to Natural History, and a discussion of the possibility of diverting the Colorado River of the West for the purpose of irrigation. Two trips were made during the season of 1875 and the subsequent winter by a party under Lieutenant Bergland, U. S. A., to make certain measurements, as well as a general examination of the subject, with unsatisfactory results as regards any information pointing to a successful accomplishment of such a scheme. These results are set forth in Appendix II. of the Annual Report of the Chief of Engineers for 1876. The report upon the collections from Indian mounds, in Southwestern California, by Drs. Yarrow, Rothwell, and others, in 1875, is undergoing examination by Professor W. F. Putnam, of Harvard College, and will soon be published.

G. GENERAL NATURAL HISTORY AND ZOOLOGY.

PROFESSOR ABBE ON THE MICROSCOPE.

Mr. W. E. Fripp has translated for the "Proceedings of the Bristol Naturalists' Society" Professor Abbe's papers on the microscope. The whole is very obscurely worded, and, either from the defects of the original or the misconception of the translator, it is so difficult of comprehension that it will prove of small value to the working optician. There are, however, many valuable suggestions, and some very extraordinary and positive statements; *e. g.*, that an adequate compensation of spherical aberration is, as a matter of fact, impossible in a dry lens when the angular aperture exceeds 110°; and that hence it must be concluded that a dry objective will be less suited for ordinary scientific use in proportion as it renders visible such finer systems of lines as exceed the limits of resolving power answering to that angle. And he states that the greatest possible increase of resolving power can be obtained in a rational way only by means of immersion objectives. The immersion lens may be made, according to Professor Abbe, with an aperture of about 100° in water, somewhat more than would correspond to 180° in air—a statement directly opposed to what Mr. Wenham has claimed. Professor Abbe states positively that there exists no microscope in which there has been seen, or will be seen, any structure which really exists in the object and is inherent in its nature, that a normal eye can not recognize with a sharply defining immersion lens magnifying eight hundred times (diameters ?).

LIMIT OF VISIBILITY IN THE MICROSCOPE.

In his recent annual address to the Microscopical Society of London, the president, Mr. H. C. Sorby, F.R.S., discusses the relation between the limits of the powers of the microscope and the size of the ultimate molecules of matter. As the combined result of observation and theory, he concludes that the normal limit of distinct visibility with the most perfect microscope is one half of the wave-length of the light.

If so, even with the very best lenses (except under special conditions), light itself is of too coarse a nature to enable us to define objects less than $\frac{1}{80000}$ to $\frac{1}{100000}$ of an inch apart. It would appear, therefore, that, as far as this question is concerned, our microscopes have already reached their ultimate limit. Adopting the results as to the size of the ultimate molecules of matter arrived at by Mr. Storey, Sir W. Thomson, and Professor Clerk-Maxwell, Mr. Sorby calculates that in the smallest interval which could be distinctly seen by the best possible microscope there would be about 2000 molecules of liquid water lying end to end, or about 520 of albumen, and that, in order to see the ultimate constitution of organic bodies, we should require a magnifying power from 500 to 2000 times greater than those we now possess. He calculates that with our highest powers we are as far from seeing the ultimate molecules of organic substances as we should be from seeing the contents of a newspaper with the naked eye at the distance of a third of a mile. A spherical particle one tenth the diameter of the smallest speck that could be clearly defined with our best and highest powers might nevertheless contain no less than one million structural molecules.

SORBY'S APPARATUS FOR MEASURING BANDS IN SPECTRA.

A plate of quartz one and a half inches in thickness is cut so that the light will pass along the line of the principal axis, and is interposed between two Nicol prisms. The whole visible spectrum is thus apparently divided into eight spaces by seven well-defined bands at equal intervals, and with this peculiarity, that on rotating the polarizer or analyzer (the upper prism is furnished with a graduated ivory circle) these black bands will move over the spectrum, occupying the original positions on completion of each half revolution. Each band gradually passes from the red end to the blue, in moving from zero to zero, over a semicircle. Of course it becomes comparatively easy to construct a table of wave-lengths, in millionths of a millimeter, corresponding to each one-tenth division between the bands. The zero point is determined by causing the upper Nicol to rotate until the centre of the second dark band from the red end of the spectrum exactly coincides with the sodium line, or solar line D.—*Monthly Microscopical Journal, December*, 1875.

NOBERT'S TEST-PLATE.

In a paper upon the measurement of the bands of Nobert's test-plate, Mr. J. A. Brown, F.R.S., arrives at the conclusion that visibility of lines of the same width increases as the distance between them decreases; that parallel lines are least visible when there are only two, and increase in visibility with their number; that Nobert's test-lines fail as a test for the microscope, especially in the highest bands, from the incapacity of the machine to make separate lines at less intervals and of less width than $\frac{1}{180000}$ of an inch; they also fail, in all probability, on account of the faintness of the tint or shade of the lines made on the retina.—*Proceedings Royal Society*, No. 163.

MÖLLER'S PROBE-PLATTE.

Professor W. Morley, of Hudson, Ohio, has published an excellent and exhaustive article on Measurements of Möller's Diatomacean Probe-platte. In a table appended, *Navicula crassinervis* is given as having 78 to 87 striæ in 0.001 of an inch; *Nitzschia curvula*, 83 to 90; and *Amphipleura pellucida*, 92 to 95 in 0.001 of an inch. Among the causes affecting the resolvability of a given diatom the author omits one that, even in tolerably experienced hands, is of no little moment—the difficulty in securing precisely the same perfect illumination upon different occasions: a difficulty so great that Messrs. Dallinger and Drysdale have contrived a special apparatus for this purpose, and the very best attainable results, as they show, depend upon such delicate manipulations of the source of illumination, as well as its character, that it is only in the ordinary way accomplished, as one might say, by accident.—*Monthly Microscopical Journal, May*, 1876.

NOBERT'S TEST-PLATES.

Mr. W. A. Rogers, of Cambridge, already favorably known for his fine rulings on glass for micrometers, test-plates, and the diffraction spectrum, has suggested a possible explanation of Nobert's method of ruling his test-plate; assuming the risk incurred in offering a theory which can at once be refuted by a single stroke of the pen. He divides the problem into two parts—the mechanical operation of moving the plate to be ruled over given and equal spaces, and the operation of producing on glass lines of varying degrees of fineness. After stating the difficulties in the use of a screw with divided micrometer head, and the errors to which such a screw, made and used with greatest care, is liable, he concludes that the periodicity always to be observed in these errors is due not to the screw itself, but to the mounting of the screw; the system of errors changing, when the same screw was employed, by slight movements of parts against which the screw worked; in fact, that these errors were due to unequal friction in the movements of the machine. The remedy proposed was to make the ways over which the gravity slide that carries the plate moves adjustable instead of fixed, and a nut at least half the length of the screw, four inches, instead of one, as at first. The gravity slide, having a hollow cylinder firmly attached to the under side, was placed on the ways, and the screw and its nut, passing through the cylinder, were adjusted in position, and then, the slide being firmly clamped on the ways, the space between the nut and the cylinder was filled in with plaster of Paris; it was thus in perfect adjustment for one position of the gravity slide, and any deviation in a horizontal direction could be corrected by means of the adjustable ways. The next operation is to space the lines accurately. For this purpose Mr. Rogers employed a very ingenious arrangement. A rigid arm, two feet in length, was placed so as to vibrate upon a shaft, set exactly in a line with the precision screw. At one end an electric magnet, fitted to the curvature of the head of the screw, was attached by light pivots in such a way as to give parallel motion with respect to the arm; the outer portion of the head of the screw was a rim of soft iron, operating as an armature. The other end of the arm worked between two stops, one of which was adjustable. When the circuit is completed, the magnet is attached to the head of the screw, and, by the movement of the arm from one stop to the other, is carried over a given space; the circuit being broken, the arm during the reverse movement carries the magnet without disturbing the screw. In order to guard, however, against any disturbance, a second magnet holds the head of the screw in place while the first one is moving back. By replacing the lower stop by a wheel revolving with the screw, the latter can be made to correct its own errors by slight changes made in the periphery of the wheel. As to how Nobert rules his lines, Mr. Rogers thinks it quite evident that it is done with a diamond having a knife-edge; and he details the method employed by himself in obtaining a suitable edge. He states that certain kinds of glass will receive perfect lines only in one direction, the glass having a certain grain, as he calls it. Perhaps this is not unconnected with the "axis of rigidity" observed by Dr. Draper in constructing his glass specula for telescopes. To avoid errors from false lines, and to obtain greater distinctness, the fine lines (ruled between two heavy finding lines) should be filled with graphite, and Mr. Rogers states that the graphite of the New York Graphite Company will easily fill the finest line that can be ruled with a diamond. When the lines are thus filled, they appear with their true width and with distinct edges. The result of Mr. Rogers' experience in ruling with a knife-edge diamond is that its ruling qualities improve with use, under certain conditions. A diamond that at first would barely rule 10,000, afterward successfully ruled bands 50,000 to the inch; this does not hold good, however, of the heavier lines required for diffraction plates. The sharp, singing sound of a perfect ruling indicates to a practiced ear the nature of the cut almost as well as the sight. In attempting to fill the lines of an injured Nobert test-plate with graphite, Mr. Rogers found it impossible to do so. Subsequently he ascertained that lines ruled by himself, but with a black carbon, not only were finer and smoother than any that he had ruled before, but that they would not receive and hold graphite. He therefore concluded that Nobert's success might consist in his use of a prepared carbon, a conclusion too hastily formed so far as graphite is concerned, for afterward he found that lines ruled with the same carbon, but held at a different inclination, would receive the graphite. The best results, however, have been obtained with the prepared carbon; though it is capricious in its action, it is much harder than any other kind of diamond.—*Proceedings of the American Academy of Arts and Sciences.*

SPECTROSCOPIC EXAMINATION OF BLOOD-STAINS.

The following process for procuring a strong solution of hæmoglobin for the microscopic test of blood-stains is recommended by Dr. Richardson. Procure a glass slide with a circular excavation, and moisten the edges of the cavity with diluted glycerine. On a clean glass cover, a little larger than the cavity, deposit a very minute drop of glycerine, and in this put the tiniest fragment of a fresh-dried blood-clot; invert the slide upon the thin glass cover, and the glycerined edges of the cavity of the former will adhere to the margin of the latter, and the whole can then be put under the microscope. If only a suspected blood-spot, then two or three minute particles of the reddish substance are placed in a minute drop of a three fourths per cent. salt solution, using for this purpose tartrate of ammonium and protosulphate of iron.—*Monthly Microscopical Journal, January*, 1876.

MICROSCOPIC DETERMINATION OF BLOOD-STAINS.

The examination of supposed blood-stains, and the assertion that human blood-corpuscles can be clearly distinguished from those of the dog and guinea-pig, has stimulated observers in devising means for more readily and accurately measuring the corpuscles, and preserving them, as it were, for future study and remeasurement. Professor Gulliver, whose measurements of blood-corpuscles are those most frequently cited, has stated, in a communication on the "Sizes and Shapes of the Red Corpuscles of the Blood of Vertebrates," etc., in the Proceedings of the Zoological Society of London, June 15, 1875, that the magnitude of the corpuscles in a single species is liable to certain variations, and that in the same field of vision differences may be observed amounting to at least one third larger and smaller than the average. To lessen, as far as possible, the expenditure of time, and to furnish a means of making comparative measurements more accurately, Dr. J. J. Woodward has proposed to photograph the blood-corpuscles placed on the stage micrometer, both blood and micrometer appearing sharply defined in the picture. The measurements are to be made on the negative. He spreads the fresh blood on the micrometer, after Dr. C. Johnston's method, by means of the edge of a glass slide, and the photograph is made by immersion objectives of high power, avoiding diffraction fringes in the images by means of a suitable condensing lens. A heliostat is not necessary to obtain good results, though Dr. Woodward recommends its use as a great time-saver, as without it the light must be readjusted for every picture. The measurements are to be made on the negative, to avoid the unequal shrinkage of paper prints. The true magnifying power is obtained by measuring the distance of the lines of the micrometer from centre to centre in the negative, and dividing by their true distance apart. Dr. Woodward states that, say twenty-five to fifty negatives, containing from 50 to 175 corpuscles each, can be made, and the corpuscles measured, in less than a quarter of the time necessary to measure the same number of corpuscles in the microscope by means of a glass eye-piece micrometer, and in less than a tenth of the time necessary if a cobweb micrometer be used, and with infinitely more accuracy. One great source of error in measuring dried blood-corpuscles has been that they have been measured in only one direction, whereas a large proportion became more or less elliptical in drying. Dr. Woodward has little faith in the claims of those who have stated or insinuated that they possess the power of discriminating human blood from that of other animals in the dried stains which are submitted to examination in criminal cases. He acknowledges, however, that the average of all the measurements of human blood that he has made is rather larger than the average of all the measurements of dog's blood; but states that it is not rare to find specimens of dog's blood in which the average size of the corpuscles is larger than that of many samples of human blood, and, indeed, on six of the thirteen negatives of dog's blood of which he furnishes tabular measurements, the average size of the corpuscles proves to be larger than the smallest average for human blood, and very diverse averages were obtained with the human and the dog's blood from different parts of the very same drop. The two tables of measurements are, of human blood, from twenty-two negatives taken from nine drops of blood, from eight individuals; and of dog's blood, from thirteen negatives from five drops of blood from a single individual; and of guinea-pig's blood, from four negatives, made from different parts of a single drop of blood.

One of these latter gave an average one millionth of an inch smaller than the smallest average for human blood; all the others gave averages larger than the smallest for human blood; and the doctor states that, in his opinion, no one could have told from the examination of this drop of blood whether it belonged to the guinea-pig, the dog, or man.—*Monthly Microscopical Journal, September*, 1876.

AIR GERMS.

The analyses of the air and other experiments made by Pasteur for the purpose of investigating the doctrine of spontaneous generation have demonstrated that the germs of inferior organisms, micrococci, bacteria, etc., are every where present in the air. In a hospital the air contains a great number of these elements, and, in addition, certain special bodies, such as pus globules and spores of epiphytic parasites, which emanate from diseased organisms, and owing to their volatility after desiccation are susceptible of hovering in the atmosphere. One square meter of the wall in the surgical ward of La Pitié having been washed, after neglect of two years, the liquid expressed from the sponge (about thirty grammes) was examined immediately afterward. It was black, and showed micrococcus in large amount, bacteria, epithelial cells, pus globules, red globules, and irregular blackish masses and ovoid bodies of unknown nature. More recently Dr. Esbeth, of Zurich, has, says the *Medical Record*, found, by the aid of the microscope, in the sweat from the face, axilla, breast, and thigh, enormous numbers of bacteria. They appear to have originated from minute bodies found upon the hairs in the mentioned regions, forming little nodules on them, and appearing as accumulations of micrococci.

POLARIZING CRYSTALS.

Mr. C. Merriman gives the following hints on "Polarizing Crystallizations." All solutions must be in distilled water, and carefully filtered. Solution of gum arabic must be added to the crystalline solution until the drops will dry on the slide without crystallizing. Then the drop on the slide is to be held over steam until one or more points of crystallization appear, then at once dried over an alcohol lamp; then held over the steam again until the crystals have grown a trifle larger, and so on until the specimen is satisfactory. The specimens are to be first varnished over with a film of collodion, and then mounted in old Canada balsam.—*American Naturalist*, *May*, 1876.

ORIGIN OF THE RED CLAY OF DEEP-SEA SOUNDINGS.

Dr. Carpenter, at the Bristol meeting of the British Association, questioned the theory of Dr. Wyville Thompson on the origin of the red clay universally found in the deepest sea soundings. Dr. Thompson supposed it the residue, after the calcareous portion of the shell had been dissolved by the excess of carbonic acid, the mineral matter not calcareous left behind being a red silicate of iron; and in support of this view Dr. Thompson stated he had obtained a similar deposit of "red ash," as he terms it, from the ordinary foraminiferous ooze, after removing the calcareous portion by dilute acid. Dr. Carpenter, referring to the discovery of casts of the foraminifera in the greensands, and especially as noted by the late Professor Bailey, considers that the red clay, instead of being the ash from the foraminiferous shells, was but the higher oxidization of the iron of the internal casts, and the disintegration of them by the action of carbonic acid. The casts are formed by the decomposition of the animal, when the silicates precipitated from sea-water take the place of the animal substances, particle by particle, filling completely the cavities of these minute shells with green or ochrey silicates.

SORBY ON LIMITS OF VISION.

Mr. Sorby's address, at the annual meeting of the Royal Microscopical Society, on the ultimate limits of the microscope, as shown by the formula of Helmholtz, has elicited a reply from Count Castracane. He states that the resolution of the nineteenth band of Nobert's test-plate exceeds the limit determined by the formula, and Mr. Sorby is called upon to explain the discrepancy. Mr. Sorby does not perceive any serious difficulty in explaining on Helmholtz's principles the resolution of the band in question, and he states that it is probable, with such an illumination as that adopted by Count Castracane, that the interference fringes would so far coincide with the true lines as not to prevent satisfactory definition; and he suggests, for the purpose of testing the theory of Helmholtz, the study of fine lines at very close but *unequal* intervals, with one or two *missed out* here and there. Theory indicates that such tests would be far more difficult to see correctly than lines ruled at regular and equal intervals.—*Monthly Microscop. Journ., July*, 1876.

BLOOD-CORPUSCLES OF THE BATRACHIA.

Professor Gulliver states that the blood-globules of the Batrachia are generally flat, or somewhat vaulted; in outline a well-defined oval, mixed occasionally with circular forms. Those of the *Amphiuma* are visible to the naked eye, and those of *Proteus* next in size—the latter thrice as large as in frogs and toads; an amount of difference of which there is no example either in the class of birds or reptiles.—*Proceedings Zool. Society, February*, 1876.

HELMHOLTZ ON LIMITS OF VISION.

In this paper it is stated that diffraction of the rays is beyond doubt the principal cause of the limitation of sharpness of the microscopical image. In comparison with diffraction, chromatic and spherical aberration appear to exert but an inconsiderable influence, in spite of the very large angles of incidence and divergence of rays. Considering the extreme care expended on calculation and execution of lenses for telescopes and the photographic camera, it is justly a matter of surprise that with the lenses of the microscope, which are so much more difficult to construct according to the prescribed dimensions, and which have so large an aperture, spherical aberration makes itself so little felt. We may add that while undoubtedly theory has very largely contributed to the perfection of the lenses for telescopes and cameras, it has hitherto done little, and, indeed, from the very nature of the case, can do comparatively little, for the perfection of the microscopical objectives. Almost all the makers of such lenses—we might say all of any note—depend upon acquired skill in the use of certain tests, *i. e.*, the artificial star, as indicating the necessary changes, in laboring toward perfection; and very seldom, we venture to say, has such perfection been the result of a rigid adherence to curves, thicknesses, apertures, etc., previously indicated by theory. Indeed, Helmholtz himself relates the failure of an attempted improvement which he thought himself justified in inferring theoretically. The whole paper is worthy of careful study, and certainly every thing which theory can give us to aid in arriving at more satisfactory conclusions should be cordially welcomed.—*Proc. Brit. Natural Soc.*, *New Series*, I., *Part* 3.

PRESERVATION OF ENTOMOLOGICAL SPECIMENS.

M. Felix Plateau having recommended the use of yellow glass in the windows of rooms containing entomological collections, as a means of preserving intact the natural colors of the specimens, M. Capronnier, of the Entomological Society of Belgium, made some experiments to determine the value of this suggestion. He made five small square boxes, each covered with a pane of yellow, violet, green, blue, or colorless glass. He then fixed in the middle of each box one of the inferior wings of *Euchelia Jacobeæ*, which are of a deep carmine color, uniform in tone. Each wing was partly covered with a band of black paper, and their position was so arranged as to leave exposed successively each of the parts during a period of fifteen, thirty, and ninety days. The result was as follows: *Colorless Glass.*—The carmine tint visibly attacked after exposure of fifteen days; alteration more sensible after thirty days; after ninety days the carmine had passed into a yellowish tint. *Blue.*—The same results as with colorless glass. *Green.*—A change indicated on the thirtieth day; on the ninetieth day the alteration was marked. *Yellow.*—After ninety days the carmine color almost intact. M. Capronnier accordingly concludes that a yellowish color should be preferred in every arrangement of an entomological room.

PARTHENOGENESIS IN VERTEBRATES.

Although the phenomenon of parthenogenesis, or development of the embryo, without contact with the male element, has been of late well observed and appreciated among the invertebrates, it has been supposed that the vertebrates, as a group, formed an exception. Recent experiments by Moquin-Tandon, confirm the observations of Bischoff and Leuckart upon the eggs at least of the frog. In a recent communication to the Academy of Science, Moquin-Tandon remarks that in the month of March last he obtained a gravid female frog, which he kept carefully away from any male; that in July the female laid a certain number of eggs, which certainly had not been impregnated in any way. He found, however, that in a number of these, although not in all, the early phases at least of segmentation occurred. He observed that, according to the usual progress, first the two large meridian circles of the egg, then the equatorial circles, were filled by the appearance of the *Faltenkranz;* but, from the development of the fourth meridian circle, sometimes even before, the breaking up assumed a very remarkable degree of irregularity, the vitelline spheres being multiplied without order, and without, possibly, a recognition of the furrows to which they owed their origin. They were of unequal size, as shown both in the lower and in the upper hemisphere. This phenomenon also occurred more rapidly than the fertilized development at the same temperature. Soon, however, this phenomenon ceased, the spheres of segmentation separated, and the entire mass went into a state of decomposition. The death period of the eggs took place at different intervals in different cases.—6 *B*, *August* 30, 409.

COPE'S THEORY OF EVOLUTION.

Professor Cope has restated during the past year his theory of evolution, with some emendations suggested by Haeckel. While Darwin, he says, has been the prominent advocate of the theory of evolution, it was first presented to the scientific world in a rational form by Lamarck at the beginning of the present century. Owing to the adverse influence of Cuvier, the doctrine lay dormant for half a century, and Darwin resuscitated it, making important additions at the same time. Thus Lamarck found the variations of species to be the primary evidence of evolution by descent. Darwin enunciated the law of "natural selection" as a result of the struggle for existence, in accordance with which "the fittest" only survive. This law, now generally accepted, is Darwin's principal contribution to the doctrine. It, however, has a secondary position in relation to the *origin* of variation, which Lamarck saw, but did not account for, and which Darwin has to assume in order to have materials from which a "natural selection" can be made. Professor Cope claims that in his "Origin of Genera" it was pointed out that the most nearly related forms of animals present a relation of repression and advance, or a permanent embryonic and adult type, leaving no doubt that the one is descended from the other. This relation was termed *exact parallelism.* It was also shown that, if the embryonic form were the parent, the advanced descendant was produced by an increased rate of growth, which phenomenon was called *acceleration;* but that if the embryonic were the offspring, then its failure to attain to the condition of the parent is due to the supervention of a slower rate of growth; to this phenomenon the term *retardation* was applied. It was then shown that the *inexact parallelism* was the result of unequal acceleration or retardation. He had also shown ("Method of Creation," 1871) that the additions either appeared as *exact repetitions* of pre-existent parts, or as *modified repetitions*, the former resulting in simple, the latter in more complex organisms. Professor Haeckel, of Jena, has added the keystone to the doctrine of evolution, Cope thinks, in his *gastræa* theory. Prior to this generalization it had been impossible to determine the true relation existing between the four types of embryonic growth. But Haeckel has happily determined the existence of identical stages of growth (or segmentation) in all of the types of eggs, the last of which is the *gastrula*, and beyond which the identity ceases. Not that the four types of gastrula are without difference, but this difference may be accounted for on plain principles. In 1874 Haeckel, in his "Anthropogenie," recognized the importance of the irregularity of time of appearance of the different characters of animals during the period of growth, as affecting their permanent structure. While maintaining the view that the low forms represent the transitional stages of the higher, he proceeds to account for the want of exact correspondence exhibited by them at the present time by reference to this principle. He believes that the relation of parent and descendant has been concealed and changed by subsequent modifications of the order of appearance of characters in growth. To the original, simple descent he applies the term *palingenesis;* to the modified and later growth, *cœnogenesis.* The causes of the changes from palingenesis to cœnogenesis he regards as three, viz., acceleration, retardation, and heterotopy.

It is clear that the two types of growth distinguished by Professor Haeckel are those which had been pointed out by Professor Cope in the "Origin of Genera" as producing the relations of "exact" and "inexact parallelism;" and that his explanation of the origin of the latter relation by acceleration or retardation is the same as that of the latter essay.—*Proc. Acad. Nat. Science, Philadelphia, Feb.*, 1876.

CEPHALIZATION A FUNDAMENTAL PRINCIPLE IN THE DEVELOPMENT OF ANIMALS.

As an example of this principle among mammals, Professor Dana says that the lowest forms are those having their locomotive functions located in the posterior parts of the body, and that in the higher the forces or force-organs are more and more forward in the structure. For example, in the whale the tail is the propelling organ, and is of enormous power and magnitude, and the brain is very small, and is situated far from the head-extremity in a great mass of flesh and bone, furnished with poor organs of sense; a grade up, in the horse or ox, the tail or posterior extremity is no longer an organ of locomotion, and is little more than a caudal whiplash, and locomotion is performed by organs situated more anteriorly—the legs; and a well-formed head carries a brain which is a vastly higher organ of intelligence than that of the whale—but the legs are simply organs of locomotion, and the hinder are the more powerful; and higher up, in the tiger or cat, the fore-legs—not the hind-legs—are the organs of chief muscular force, and these have higher functions than that of simple locomotion; and, further, the body is proportionately shortened, and the head is shortened anteriorly, or in the jaws, and approximates thus toward the condition in man. The existence or not of a switch-like tail, as in ordinary quadrupeds, has little bearing on the question of degree of cephalization, since the organ is not an organ of locomotion, or one indicating a large posterior development of muscular force. But, approaching man in the system of life, even this seems to have significance. The principle of cephalization is believed to be fundamental, "because, first, the chief centre of nervous power or energy in an animal is at the cephalic extremity; and, secondly, because form in nature's species is, with some limitations, an expression of force."

"We recognize, as evidence of upward progress in man, an increasing height, width and erectness of the forehead, and a shortening of his jaws, and see therein evidence of improved intellect; which means higher grade of cephalization. But, more than this, the erect form of man, the shortened arms, the naked skin, as well as the large, smooth-surfaced cranium, may also be as directly and necessarily connected with and dependent upon his superior degree of cephalization in the system of animal life; while the hairy skin, the long arms, the crested skull, the inclined posture of the man-ape, may be all involved in the ape's inferior degree of cephalization. If so, the development of the brain in man, and of all the highest structural perfections of the vertebrate type which he exhibits, is inconsistent with the existence of the hairy covering and some other circumferential as well as interior characteristics of the brute." In this article Professor Dana seems to indorse in a partial way the doctrine of evolution, remarking that "the present state of science favors the view of progress through the derivation of species from species, with few occasions for divine intervention. If then there has been derivation of species from species, we may believe that all actual struggles and rivalries among animals, leading to a 'survival of the fittest,' must tend, as in man, to progress in cephalization, and dependent structural changes. In fact, mere living, the surmounting of the daily obstacles in getting food and shelter and satisfying ordinary desires, may have given growth to the brains and structures of the Eocene mammals, aiding, but perhaps exceeding, all other influences from environments. The source of variation here pointed out is not at all at variance with Darwinism. Darwin, in fact, does not aim to explain the origin of variation among species, but chiefly the workings of natural selection—variations being in progress by some means—in leading to the 'survival of the fittest' of the varieties. Variation he refers to environments, and especially to action on the genital system. The genital system may have this prominence in plants, but for animals I would give the *nervous* system the higher place, inasmuch as upon it environments make their first and most powerful impress."—*American Journal of Science and Arts, October*, 1876.

ORIGIN OF THE SEXES IN VEGETABLES AND ANIMALS.

Some facts tending toward an explanation of this subject have been afforded by Henneguy in his studies on the *Volvox*, a low plant. He finds that during a certain period the *Volvox* is multiplied by a sexual generation, by fission (scissiparity) of a vegetative cell, which by successive segmentations produces a colony of individuals similar to the mother-colony to which this cell belonged. But a time comes when the vegetative cell no longer possesses the property of reproducing itself thus; it can still, however, divide into segments, and give birth to a colony of little cells which acquire a sexual character; that is to say, they are incapable of living separately and of reproducing themselves. This abortive daughter-colony constitutes the male element, endowed with movement, and still enjoying a certain activity. Soon the vegetative cell becomes incapable of segmenting; it can only increase in volume: it is the female element deprived of motion, which requires, in order to reproduce itself, to fuse with the male element. Sexuality in *Volvox* appears then by degrees, the male sex appearing before the female sex as fast as the species exhausts itself by a sexual reproduction.

We must compare this fact, says Henneguy, with what takes place in the animal kingdom in those animals which are reproduced by parthenogenesis. Professor Balbiani has observed that certain Aphides and the *Phylloxeræ* degenerate when they are reproduced during a certain time by parthenogenesis; their genital and digestive organs tend to become atrophied. There is a time when the parthenogenetic individuals thus degraded give origin first to male individuals, then to female individuals, which require to be fecundated to reproduce new parthenogenetic individuals.—*Ann. Mag. of Natural History, September.*

THE BORDER-LINE BETWEEN PLANTS AND ANIMALS.

The boundary-line between animals and plants has again been effaced by the studies of Cienkowsky on a monad (*Diplophrys stercorea*). These little bodies, which he observed in moist horse-manure, multiply by division, and form, by the union of pseudopodia, long strings, in which separate individuals can glide to and fro. In several of the organisms he examined, Cienkowsky was able to observe the taking up of solid food by the suction of algæ. Thus the boundary-lines, it is added by the commentator, a German correspondent of *Nature*, which it has so long been usual to draw between plant and animal organisms, and between the individual groups of those lowest forms of life, appear more and more illusory; and the supposition is recommended of a common lowest kingdom of organisms—that of the *Protista* of Haeckel—out of which animals and plants have by degrees been differentiated.

ARCHEBIOSIS.

The Tyndall and Bartian controversy is still *sub-judice.* The simple question is, Can air retaining all its gaseous mixtures, but self-cleansed from mechanically suspended matter, produce putrefaction? In all the various experiments made by Dr. Tyndall, when the substances were exposed to common air at a temperature of 60° to 70°, all fell into a state of putrefaction in from two to four days—not one in 600 escaped; but in no instance did air which had been proved moteless by passing a concentrated beam of light through it show the least power of producing bacterial life, or the associated phenomena of putrefaction. Both sides are preparing further experiments. Thus far, however, Dr. Tyndall has come out of the controversy with all the weight of scientific evidence and philosophic gravity of discussion on his side, while Dr. Bartian has done injury to his cause by adopting the well-known symptom of defeat, "abuse of the plaintiff's attorney."—*Brit. Med. Journal, January* 29, *February* 5 *and* 12.

EVOLUTION OF THE HORSE.

Professor Huxley devotes the sixth and last lecture of a course upon the origin of existing vertebrate animals to considering the evolution of the horse. After tracing the genealogy of the horse from Orohippus, through Paleotherium, Hipparion, etc., to Equus, the author remarks as follows: "The evidence is conclusive as far as the fact of evolution is concerned, for it is preposterous to assume that each member of this perfect series of forms has been specially created; and if it can be proved, as the facts certainly do prove, that a complicated animal like the horse may have arisen by gradual modification of a lower and less specialized form, there is surely no reason to think that other animals have arisen in a different way. This case, moreover, is not isolated. Every new investigation into the Tertiary mammalian fauna brings fresh evidence, tending to show how the rhinoceros, the pigs, the ruminants, have come about. Similar light is being thrown on the origin of the carnivora, and also, in a less degree, on that of all the other groups of animals. It is not, however, to be expected that there should be, as yet, an answer to every difficulty, for we are only just beginning the study of biological facts from the evolutionary point of view. Still, when we look back twenty years to the publication of the 'Origin of Species,' we are filled with astonishment at the progress of our knowledge, and especially at the immense strides it has made in the region of paleontological research. The accurate information obtained in this department of science has put the *fact* of evolution beyond a doubt; formerly the great reproach to the theory was that no support was lent to it by the geological history of living things; now, whatever happens, the fact remains that the hypothesis is founded on the firm basis of paleontological evidence."

PROFESSOR MARSH'S PALEONTOLOGICAL DISCOVERIES.

Professor O. C. Marsh, in a lecture to the graduating class of Yale College, summed up the main results of his paleontological researches in the Rocky Mountains. A syllabus of the lecture is published in the *American Journal of Science*. His conclusions as to the size and growth of the brain in mammals, from the beginning of the Tertiary to the present time, may be briefly stated thus: 1. All tertiary mammals had small brains. 2. There was a gradual increase in the size of the brain during this period. 3. This increase was mainly confined to the cerebral hemispheres. 4. In some groups the convolutions of the brain have gradually become more complicated. 5. In some the cerebellum and olfactory lobes have even diminished in size. There is some evidence that the same law of brain-growth holds good for birds and reptiles from the Cretaceous to the present time. Some additional conclusions in regard to American tertiary mammals, as far as now known, are as follows: 1. All the Ungulata from the eocene and miocene had upper and lower incisors. 2. All eocene and miocene mammals had separate scaphoid and lunar bones. 3. All mammals from these formations had separate metapodial bones. At the conclusion of the lecture, Professor Marsh announced that his work in the field was essentially completed, and that all the fossil remains collected and in part described were now in the Yale College Museum. In future he should devote himself to their study and full description, and he hoped at no distant day to make public the complete results.—*Popular Science Monthly*, *November.*

MIMICRY IN BUTTERFLIES EXPLAINED BY NATURAL SELECTION.

Fritz Müller, in the Jena *Zeitschrift*, endeavors to show how the phenomena of mimicry in butterflies may be explained by the theory of natural selection. He bases his inquiry upon the species of *Leptalis* found in Southern Brazil, and although, as will appear below, he adduces reasons for believing the primitive stock to have been banded, and not, like most of the family to which the genus belongs, simple white butterflies, he commences by showing how even such an extreme change could be wrought out by the survival of the fittest in the struggle for existence. "Should," he remarks, "the first unimportant variations from the original white color (of the Pierids) be useful only in attracting to their possessors, at a little shorter distance, the attention of enemies flying constantly overhead, they would become more and more useful, and cause their possessors to become continually more abundant in proportion to the type; they could therefore serve as the basis for the gradual formation of a resemblance fit to deceive even the sharp eyes of birds scanning the swarms of Ithonias (the butterflies imitated by some Leptalids) for booty." Further on he asserts that "the acceptance, as the starting-point in the origin of mimicry by natural selection, of a resemblance having its beginning at such a distance can scarcely be shaken by a single known case. It should, moreover, not escape attention that the sharp-sightedness of enemies is itself also a quality at first gradually acquired in the struggle for existence, and one which must increase from the very fact that by protective coloring, mimicry, etc., the persecuted species escapes the less sharp-sighted pursuer. This ever-increasing sensitiveness and sharp-sightedness of the pursuer on the one hand explains the wonderful completeness of many natural imitations, and on the other makes the acceptation of an originally very slight resemblance the less hazardous."—*American Naturalist, September.*

CONVERSION OF ARTERIAL INTO VENOUS BLOOD.

A method has been proposed by Schützenberger for exhibiting the conversion of arterial into venous blood, by the deoxidation of the former by means of the absorptive power of yeast for oxygen. Thus if blood, inclosed in a thin membrane, be immersed in water mixed with yeast, and the whole exposed to a temperature of 95°, it will become venous in the course of an hour. By shaking it with air it will reabsorb oxygen, and be reconverted into arterial blood. An apparatus has been perfected upon the above principle, from which red arterial blood passed into it flows out as black venous blood, and is then again saturated with oxygen, and passed back into the apparatus.—8 *C, January* 7, 1875, 12.

DO ACIDS COAGULATE THE BLOOD?

M. Oré, inquiring whether or not acids coagulate the blood, has tried a number of curious experiments by means of subcutaneous injections. On several different occasions he injected into the veins of a dog quantities of dilute acetic acid, containing from six to twenty-five grammes of the substance itself. The treatment seemed in each case to be wholly innocuous, and no coagulation occurred. Two and a half grammes of sulphuric acid, diluted with sixty of water, injected into another dog, caused a brief panting, but no other perceptible effect. Four days later the creature was killed, but no traces of coagulation were any where to be detected in it. Somewhat similar results were furnished by the injection into various dogs of nitric, phosphoric, and chlorhydric acids, and also of alcohol. These substances, mingled with blood in free contact with the air, all cause coagulation; but in the veins no such effect is produced.—6 *B*, 1875, *Nov.* 8.

CAUSES AND MECHANISM OF THE COAGULATION OF FLUIDS.

Messrs. Matthieu and Urbain have recently made some very important experiments upon the causes and mechanism of the coagulation of fluids, particularly of the blood, which they liken to a chemical precipitation. The transformation of the soluble to an insoluble substance is produced by an acid, whose effect is generally counteracted by the alkalinities of the fluid. The acid exists in none of the normal fluids of the body except the blood. They make the following points concerning it: 1. Carbonic acid is the agent in coagulating the albumen. It only does this at an elevated temperature, because of the ammoniacal salts which must be volatilized. Cold albumen, if deprived of its ammonia, will be precipitated by the acid. 2. Carbonic acid is also the cause of the coagulation of fibrin, and blood deprived of it is incoagulable. It can not produce this effect, however, normally, because it is combined in the red globules which have a great affinity for the gas. When the organs for its excretion, viz., the lungs and the skin, do not perform their function, the acid accumulates and produces intravascular coagulation; as, for example, in death by suffocation. By a similar accumulation beyond the limit of saturation of the blood-globules in the case of ligature of a vessel coagulation is produced. Venous clots are formed in the course of debilitating diseases because of a degeneration of the red globules and loss of power to hold the acid gas. 3. Cadaveric rigidity is produced by an accumulation in the muscles of this same agent, developed by the slow oxidation of the tissues. 4. The coagulation of milk is preceded by analogous processes to those which induce the muscular coagulation of *rigor mortis;* in the former case, however, lactic acid is produced, which coagulates the casein at an ordinary temperature.

NATURE OF GASES DISCHARGED FROM THE STOMACH.

The precise nature of the gases emitted by the mouth from the stomach has not been well established, although the occurrence of that of free hydrogen is shown by the fact that they burn with a blue flame. Quite lately Ewald described the case of a person suffering from chronic gastritis, who, on lighting a cigar one day, was surprised to see this gas take fire and burn with a yellow flame. By subjecting this to a chemical examination, it was found to consist, with other substances, of a considerable portion of marsh gas, not previously known as a product of the stomach.—18 *A*, *March* 10, 1876, 658.

PHYSIOLOGICAL ACTION OF ALCOHOL.

Dr. Lander Brunton, in a summary of a memoir before the Medical Society of London, regarding the physiological action of alcohol, states that in small quantities it increases the secretions of the gastric juice, and thus aids digestion. However unnecessary this may be in health, it is useful for the feeble and debilitated. Second, it increases the force and frequency of the pulse. Third, a large dose diminishes digestion by the too great irritation of the stomach. Fourth, it is capable of producing death by reflex action. Fifth, after absorption in the blood it diminishes the power of oxidizing the red globules of the blood. This is useful in lowering the temperature; but when this is done suddenly or very frequently it causes an accumulation of fat and a fatty degeneration of the organs. Sixth, it undergoes a sort of combustion in the organism, and maintains the increase of weight of the body. In this respect it may be considered as a food. Seventh, if taken in large doses, a portion is excreted in an unaltered condition. Eighth, it dilates the blood-vessels, increasing the force and frequency of pulsations of the heart by its action on the central nerves, and facilitates intellectual and physical action. It does not give any greater power, but renders a man capable of keeping more energy in reserve. It can thus furnish assistance to effort of short duration, but not for prolonged exercise. Ninth, it has the same effect upon the heart; but in disease alcohol frequently relaxes the pulsations of this organ instead of accelerating them, thus economizing the energy instead of wasting it. Tenth, in dilating the vessels of the skin, alcohol cools the surface at the expense of the internal organs. It is thus injurious when taken during exposure, but after such exposure it is useful as tending to prevent the congestion of the internal organs. Eleventh, the symptoms of intoxication are due to a paralysis of the nervous system; the brain and the cerebellum are first affected, then the protuberance, and finally the medulla oblongata. Death by alcohol is generally caused by paralysis of the medulla.—12 *B*, *February* 29, 1876, 184.

NATURE OF THE INVERTEBRATE BRAIN.

Under this heading Professor Bastian describes, in a popular way, the brains of different articulated animals, beginning with those of the lowest nematoid worms and ending with those of the insects. As examples of the two extremes may be first cited that of the nematoid parasitic worm, in which what most nearly resembles a brain consists of a mere band of nerve-fibres surrounding the commencement of the œsophagus, and containing a few nerve-cells, partly between its fibres and partly in groups slightly removed therefrom. In such insects as butterflies, bees, and dragon-flies, in which the visual organs are enormously developed, and in which the power of vigorous and sustained flight is correspondingly increased, the nervous system attains its maximum of development among the *Arthropoda*. The brain of these creatures differs from that existing in all other members of the class by reason of the great development of those portions of it in relation with the visual organs. The "brain" proper in all the invertebrate animals consists properly of but a single pair of ganglia, and is in no respect homologous with the brain of the vertebrates, which consists of a number of pairs of ganglia forming a mass called the *brain*.—*Popular Science Monthly*, *October*, 1876.

ACTION OF OZONE-WATER ON THE LOWER ORGANISMS.

Herr Stein reports to the Natural History Society at Bonn that he has confirmed the observation of Dr. Geisler, that in water impregnated with ozone none of the lower organisms, either animal or vegetable, can develop; that, in fact, if they are present, they are destroyed, and without any notable evolution of gas, but the formation principally of nitric acid and its combinations. Having, however, been informed that Professor Hanstein had shown that the water-plant *Elodea Canadensis* had the remarkable power of developing oxygen, he repeated the experiment, and found that the oxygen developed by this plant had the same properties as ozone; so that this plant should no longer be called, as it is, in German, a "water pest," but rather be known by the title of "fever destroyer." At any time swamp waters may be purified by introducing the *Elodea*, after which they become fit abodes for fishes and other animal life. — *Sitzber. Bonn*, p. 62.

THE EFFECT OF THE PRESSURE OF THE AIR UPON HUMAN LIFE.

Dr. Jourdanet, who has for many years resided at Mexico as a practicing physician, has had occasion to observe the effect upon human life of different conditions as to altitude above the sea, and has recently published, in two large volumes, an important work on this subject. In this work he has grouped together facts collected from all portions of the globe, and with much sagacity and honesty has been able to achieve something exact with respect to the effect of altitude upon human life. The fundamental principle adopted by him has been that the true nature of the effect of exterior influences is better shown by the diseases that they cause than by the healthfulness which they favor in man. After studying the influence of the oxygen of the atmosphere upon the blood, and even the diminution of temperature with increasing height above the sea, and, finally, the influence of the hygrometric state of the air, he combines all these considerations in the general study of climatic influence of high altitudes, and confirms the following law of Paul Bert for pressures of 30 inches and less: "The exercise of that faculty which animals possess of appropriating to themselves the oxygen of the atmosphere is controlled by the density of this gas, as found in the circumambient air." Death is not, then, caused by the prevailing low atmospheric pressure. It is the oxygen itself, or its pressure, exclusive of the general barometric condition, that controls the result; so that if from a pressure of 30 inches of air, one third of which is oxygen, we pass to another atmosphere with a pressure of 15 inches of air, two thirds of which is oxygen, we have conditions equally favorable to human life, since, for equal volumes of air, we find equal volumes of oxygen.—*La Aeronaute*, *Sept.*, 1875, 261.

LUBBOCK ON THE SENSES OF INSECTS.

Much has been written on the use of the antennæ of insects. That they serve as organs of touch all are agreed; but it is almost equally clear that this is not in most cases their only function. Some entomologists regard them as auditory, some as olfactory organs. There is, however, a third alternative, which I would venture to suggest, namely, that in those insects in which the sense of hearing is highly developed they may serve as ears, while in those which have a very delicate sense of smell they may act as olfactory organs. This view is not in itself so improbable as might at first sight appear. It is evident that, in the Articulata, organs of sense are developed in various parts of the body. Whether the curious organ discovered by Müller in the metathorax of certain Orthoptera be an ear or not, it must surely be an organ of some sense. Hicks and others have described structures in the halteres and wings of insects which have all the appearance of being organs of sense; while among the Crustacea we find the remarkable case of *Mysis*, which even has an organ of sense in its tail. It is not, then, so improbable as might at first sight appear that the antennæ should in some species act as ears and in others serve for the perception of odors. The position, moreover, which they occupy renders them a most advantageous situation for an organ of sense. This suggestion would also explain various experiments and observations recorded by skillful entomologists, and which it is otherwise difficult to reconcile with one another.

Many eminent observers have regarded the antennæ as auditory organs, and have brought forward strong evidence in favor of their view. Lespés, for instance, found that a female *Locusta viridissima*, which was very sensitive to sound, lost apparently all power of hearing when the antennæ were removed. She lived a fortnight longer and continued to eat. M. Lespés observed no other result except the loss of hearing.

So far as I am aware, no proof has yet been adduced that ants possess the power of hearing. In order, if possible, to throw some light upon this interesting question, I made a variety of loud noises, including those produced by a complete set of tuning-forks, as near as possible to the ants mentioned in the preceding pages, while they were on their journeys to and fro between the nests and the larvæ. In these cases the ants were moving at a steady pace and in a most business-like manner, and any start or alteration of pace would have been at once apparent. I was never able, however, to perceive that they took the slightest notice of any of these sounds. Thinking, however, that they might perhaps be too much absorbed by the idea of the larvæ to take any notice of my interruptions, I took one or two ants at random and put them on a strip of paper, the two ends of which were supported by pins with their bases in water. The ants imprisoned under these circumstances wandered slowly backward and forward along the paper. As they did so, I tested them in the same manner as before, but was unable to perceive that they took the slightest notice of any sound which I was able to produce. I then took a large female of *F. ligniperda*, and tethered her on a board to a pin by a delicate thread about six inches in length. After wandering about for a while, she stood still, and I then tried her as before; but, like the other ants, she took no notice whatever of the sounds.

It is of course possible, however, if not probable, that ants, even if deaf to sounds which we hear, may hear others to which we are deaf. On this subject I hope to make some experiments, in which Mr. Spottiswoode has kindly promised to assist me.—*Journal of the Linnæan Society.*

THE SENSE OF SMELL IN INSECTS.

I have also made similar experiments, though with very different results, on the power of smell possessed by ants. I dipped camel's-hair brushes into peppermint-water, essence of cloves, lavender-water, and other strong scents, and suspended them about a quarter of an inch above the strips of paper along which the ants were passing in the experiments above recorded. Under these circumstances, while some of the ants passed on without taking any notice, others stopped when they came close to the pencil, and, evidently perceiving the smell, turned back. Soon, however, they returned and passed the scented pencil. After doing this two or three times, they generally took no further notice of the scent. This experiment left no doubt on my mind; still, to make the matter even more clear, I experimented with ants placed on an isolated strip of paper. Over the paper, and at such a distance as almost, but not quite, to touch any ant which passed under it, I again suspended a camel's-hair brush, dipped in assafœtida, lavender-water, peppermint-water, essence of cloves, and other scents. In this experiment the results were very marked, and no one who watched the behavior of the ants under these circumstances could have the slightest doubt as to their power of smell.

I then took a large female of *F. ligniperda*, and tethered her on a board by a thread as before. When she was quite quiet I tried her with the tuning-forks; but they did not disturb her in the least. I then approached the feather of a pen very quietly, so as just to touch first one and then the other of the antennæ, which, however, did not move. I then dipped the pen in essence of musk and did the same; the antenna was slowly retracted and drawn quite back. I then repeated the same with the other antenna. If I touched the antenna, the ant started away, apparently smarting. I repeated the same with essence of lavender and with a second ant.—*Journal of the Linnæan Society*, 1876.

THE WEATHER AND INSECT LIFE.

The connection between insect life and the weather is remarked upon by Mr. Cotton in some notes presented to the Waterford Natural History Society. He states the occasional appearances, in unusual numbers, of any insect, are one of the greatest puzzles to entomologists, and are not in any way satisfactorily accounted for by them. Thus a pale, cloudy-yellow butterfly was very abundant in 1846, but scarce from that year until 1868, when it was positively commoner than almost any other butterfly all along the south coast of England; in some places twenty or thirty could be seen flying at once. Since that year hardly a single specimen has been seen. Probably the occurrence of a few wet or hot or cold or dry days at the time of the hatching of the larvæ of this insect determines the question as to whether the butterfly shall be common or rare during a given season.—*Transactions of the Waterford Natural History Society*, 1875, 50.

USE OF THE BATON AMONG ANCIENT EGYPTIANS AND JEWS.

F. Chabas is the author of a pamphlet upon the use of the baton among the ancient Egyptians and the Jews. All nations of the East have considered the baton not only a staff and a weapon, but a badge of authority. The same might be said of Western peoples, whose antiquities are not so well known. The author examines into the use of the baton among these ancient nations, and gives abundant references to authorities.

SKELETONS OF PILE-DWELLING INHABITANTS.

Notwithstanding the immense number of remains of prehistoric villages and dwellings built on piles in the marshes and lakes of Central Europe, very little is known of the osteology of the builders, the burial-places having almost entirely escaped a very careful and critical search. The suggestion of the practice of cremation is met by the absence of charred bones, which would necessarily have been preserved to some extent; and immersion of the bodies in the water is disproved by the absence of any portion of the skeleton in the mud of the vicinity.

A discovery, however, has lately been made in the vicinity of one of these localities in Switzerland of a grave, which probably contains the members of a particular family. Here two large granite slabs were found, covering a chamber walled around by large vertical stone plates, and in the inclosure thus formed were found the remains of from ten to fifteen skeletons. Two skulls were in good condition; the others were fragmentary. The crania were found in the corners of the room, while the long bones were heaped up toward the middle. With these were found several perforated teeth of wild animals, a well-made axe of serpentine, bronze pins, four armlets of copper, and a bronze button.—7 *C*, III., 190.

NEW HYPOTHESIS IN REGARD TO SWISS LAKE-DWELLINGS.

A new hypothesis in regard to the lake-dwellings of Switzerland has lately been suggested to Dr. Robert by a lady, whose name he does not give. In her opinion, all or nearly all of these lake-dwellings were originally established in marshes or boggy places, selected, perhaps, on account of the comparative absence of large trees; and at this period the lakes were much extended, and much more shallow than at the present day. In the course of time, however, from various conditions, the level of these lakes became raised, and the places in which the dwellings had been established became filled with water, so as possibly either to drive out the inhabitants or to envelop their dwellings after they had been abandoned.—3 *B*, *February* 10, 1875, 246.

DID MAN EXIST IN THE TERTIARY PERIOD OF EUROPE?

Not long ago much interest was attracted by the announcement of the discovery in the tertiary coal of Wetzikon, in Switzerland, of pieces of wood converted to coal, which, it was claimed, had been sharpened artificially by human hands; and a vastly greater antiquity was claimed for man in Europe than had been previously demonstrable. This inference, however, was seriously questioned by competent authority, who believed that some explanation other than that could be found for it; and now it is maintained with great show of plausibility that it is the work of the beaver or some other large rodent, or the rubbing together by floods of broken twigs.—19, XXIX., 274.

MAN IN THE POST-PLIOCENE OF BUENOS AYRES.

In a letter addressed by Mr. Florentine Ameghino to *Gervais's Journal of Zoology*, he communicates the discovery of large numbers of fossil bones at a depth of thirteen feet in an undisturbed quaternary bed near Mercedes, and about twenty leagues from Buenos Ayres. With these appeared great quantities of charcoal, baked clay, burned and scratched bones, arrow-points, knives and chisels of flint, and a large number of bones belonging to some fifteen species of mammalia which are for the most part extinct—among them *Holophorus ornatus*, *Holophorus burmeisteri*, *Lagostomus angustidens*, *Canis protalopex*, *Eutatus seguini*, and *Triodon mercedensis.*

In various places along the Rio Lugan, near Mercedes and Lugan, he found the bones of extinct species, worked by human hands, together with knives and stone implements of various kinds. The species identified by him are the *Mastodon humboldtii*, *Mylodon robustus*, *Ursus bonariensis*, *Pampatherium typus*, *Bos pampæus*, *Toxodon platensis*, *Lagostomus fossilis*, *Glyptodon elongatus*, *Vulpes fossilis*, *Equus curvidens*, and *Equus neogæus.*—14 *B*, IV., 526.

LAURIUM SILVER MINE.

The following statement—highly interesting if true—is now being circulated on the basis of "a letter just received from Greece." The original Laurium Company, which almost provoked an international conflict, while working the surface at Laurium purchased the subsoil corresponding to that surface. The subsoil was not (avowedly, at least) explored, and remained unworked and unknown. Recently, however, the company, having sold the surface only to their successors, employed an engineer to examine this subsoil. His research was rewarded by the discovery of a number of wells, now filled up, which had served in ancient times for the working of the mines. In one of these mines, situated about the centre of the tract, and which appeared as though abandoned for ages, he found the miners' tools and heaps of ore about them—the mine, in short, in the very state the Greeks, surprised, doubtless, by some unexpected attack, had left it. Encouraged by this unexpected discovery, excavations were made, which are affirmed to have brought to light deposits of silver, lead, and calamine of incalculable richness. Presuming the foregoing to be true, it would disprove the current belief that these mines had been abandoned on account of their exhaustion.

FEMALE CLOTHING IN THE BRONZE PERIOD.

There is no subject at present which excites more interest than information in regard to the manners and customs of the prehistoric races of the world, any hint, however slight, being eagerly seized upon to assist in increasing our knowledge in this direction. The peculiarities of the skeletons are, of course, well known from the remains extant, the bones resisting the ordinary agencies of destruction. So with the greater portion of the implements and utensils used by these people, whether of wood, bone, stone, or metal. The case is quite different, however, in so far as human lineaments are concerned, the instances of corpses preserved, with the flesh and the skin in a better or worse state, being very rare; but when occasionally these are found, clothed, in exceptionally secure resting-places, the record of their discovery is eagerly scanned.

Quite lately, in excavating a tumulus of the bronze period in Jutland, Denmark, three oaken coffins were met with. In one was found a skeleton of a woman clothed in a woolen chemise with a long skirt. Around the loins was a girdle, and the whole body was enveloped in a woolen cloak. Upon the head was a fillet of hair with a bronze diadem, the arm was ornamented with bracelets, and a band was around the neck, all of bronze. In the middle of the coffin was a beautiful clay vase, and a bronze dagger with a horn handle.

The skeleton of a young man was found in another coffin covered with a cloak fastened together with a pin. By the side was the scabbard of a long sword, in which was inserted a small bronze dagger. A box made of bark was near the head.

The third coffin contained the skeleton of an adult female covered with a cloak. Around the loins was fastened a short skirt of woolen tissue, with a cincture formed with twisted woolen threads, and on the head was a woolen hood.

In the same tumulus was a large square cavity inclosed by numerous stones, in which were several swords and daggers in bronze, and a double bronze button covered with gold. Under the sod which covered this tumulus was found a pile of small stones, a knife, and various other articles.—20 *B*, VI., 509.

JADE AND NEPHRITE.

An interesting volume of four hundred pages has been recently published by Professor Fischer, of Freiburg, upon the minerals jade and nephrite. These species have in themselves comparatively little of interest, and it seems at first a matter of surprise that so large a book should have been devoted to them. Their importance lies entirely in their relation to archæological matters; since the earliest times they have furnished a large part of the material employed for the carving of ornaments and idols. No localities are known for these minerals in Europe, and yet the exploration of the ancient buildings of the lake-dwellers and of similar prehistoric remains has brought to light hundreds of stone implements, both weapons and ornaments, made from these materials. It is supposed that the source was originally Siberia and Turkestan, and that they were introduced into Europe through the connections of trade. Professor Fischer describes in detail a large number of curiously carved idols, ornaments, charms, and amulets which have been obtained in part from

Eastern Asia and in part from Central America, and thus gives a very interesting chapter in archæology.

EXPLORATIONS AROUND THE NORTH CAPE.

Verkrüzen, who has been prosecuting zoological explorations in Northern Scandinavia, has lately returned to Frankfort, after an absence of three months spent in the Varsanger and other fiords, and around the North Cape. Notwithstanding the stormy weather, which interfered very greatly with his work, he succeeded in obtaining a very fine series of mollusks, of which some forms are remarkable for their size, compared with their representatives in more southern localities. He also obtained some good specimens of the winter clothing, etc., used by the Samoiedese and Finns, made from the skins of the reindeer.—13 *A*, *January* 22, '78.

EMBRYOLOGICAL DATA FOR THE CLASSIFICATION OF VERTEBRATES.

Kowalevsky was the first to show that the neural and alimentary canals communicate in the larval Ascidians, and also in the sharks and skates, as well as in the bony fishes, and in the lancelet (*Amphioxus*). It has also been observed in Amphibians by Goette, and by Kowalevsky, Owsjannikow, and Wagner in the sturgeon (*Acipenser*), and has been observed by Balfour in the sharks and skates. The latter embryologist states that "this communication between the neural and alimentary canals, which is coupled, as will be seen in the sequel, with the atrophy of a posterior segment of the alimentary canal, is a feature of great interest, which ought to throw considerable light upon the meaning of the neural canal. So far as we know, no suggestion as to the origin of it has yet been made."

The reptiles, birds, and mammals have usually been distinguished from other vertebrates by the possession of a well-developed allantois and amnion. Mr. Balfour thinks that "we may further say that the lower vertebrates, Pisces and Amphibia, are to be distinguished from the three above-mentioned groups of higher vertebrates by the positive embryonic character that their neural and alimentary canals at first communicate posteriorly. The presence or absence of this arrangement depends on the different positions of the embryo in the blastoderm. In reptiles, birds, and mammals the embryo occupies a central position in the blastoderm, and not, as in Pisces and Amphibia, a peripheral one at its edge."—*Journal of Anatomy and Physiology, July*, 1876.

NEW HAND-BOOK OF PALEONTOLOGY.

Zittel's hand-book of Paleontology will be welcomed by a large class of students who need something broader in scope than "Science Primers," and yet without the elaborate detail of special memoirs. The division of Palæphytology is undertaken by Professor Schimper. But one part of the work, which is to be completed in two volumes, is yet published; this, however, gives abundant promise of its excellence, when complete, as a student's text-book. The illustrative wood-cuts are worthy of highest praise; and in this first part are chiefly devoted to the Rhizopoda. Though in some points the classification and treatment of the Foraminifera are open to criticism, yet this does not affect the general usefulness and value of the work.

THE SIBERIAN MAMMOTH.

In his journey up the Yenisei River, Nordenskjöld passed through the country where remains of the mammoth abound; the teeth forming an important article of commerce. They are also believed to occur on the tundras. The larger parts of the skeleton are known to be very rare, and still rarer, mammoths with flesh, hide, and hair yet remaining. It was on the peninsula between Obi and Yenisei that the great mammoth deposit discovered by Schumachoff occurred, and in the neighborhood of the same place was found the mammoth which gave occasion to Schmitt's expedition.

SUMMARY OF MARSH'S RECENT DISCOVERIES.

In a lecture by Professor Marsh to the graduating class of Yale College, delivered in the new Peabody Museum, he gave a brief *résumé* of his investigations of the fossil vertebrates of the Rocky Mountain region, referring more particularly to the cretaceous and tertiary formations. He states that within the past six years these investigations have brought to light more than three hundred fossil species of vertebrates new to science, about two hundred of which have already been described.

Many remarkable forms of animals hitherto unknown have been revealed by Professor Marsh's researches, chief among which may be mentioned a group of birds having well-defined teeth, and constituting a new sub-class, *Odontornithes*, of two orders—one in which the teeth are in grooves, and the other in which the teeth have each a distinct socket. The former were swimmers of gigantic size, with rudimentary wings, and the vertebræ as in modern birds. The second order embraces small birds with powerful wings and biconcave vertebræ, as in *Ichthyornis*.

Another group of fossil vertebrates is that of the *Pterodactyls*, or flying reptiles, which, however, constitute a distinct order from the European. In one of these the spread of the wings amounted to twenty five feet. The class of the reptiles proved to be rich in new species, some of them lizards of sixty or more feet in length. These forms were obtained in the cretaceous formation.

The mammalia of the tertiary formation were especially interesting, among them a gigantic group of the order *Dinocerata*, nearly equal to the elephant in size, but with shorter limbs. The skull was armed with two or more pairs of horn cores, and with enormous canine tusks like those of the walrus. The brain was proportionally smaller than that of any other land mammal.

The *Tillodontia*, another new order of mammals found in the eocene deposits, possessed affinities to the carnivores, rodents, and ungulates. The remains of quadrumana were also found, related both to the lemurs of the Old World and to some of the South American monkeys. Among the eocene mammals a small hoofed animal was found, supposed to be the oldest probable ancestor of the horse. It was about as large as a fox, with four toes before and three behind. Among other mammals was a group allied to the modern rhinoceros.

Belonging to the *Brontotheridæ* is a wonderful beast, as large as the Dinocerata, having an elevated pair of horn cores on the maxillary bones; it was found among the mammals of the miocene. A small equine animal, as large as a sheep, and having three toes on each foot, with an additional "splint" bone on those in front, was also found, thus forming an interesting miocene link in the genealogy of the horse.

Over thirty species of fossil horses were found; as also a species of rhinoceros, camels, suillines, and other large mammals, etc.—4 *D*, *July*, 1876.

HABITS OF AMERICAN FRESH-WATER RHIZOPODS.

Professor Leidy, in continuation of his studies on our American fresh-water Rhizopods, describes the habits of the genus *Hyalosphænia*, the shell of which is homogeneous and transparent. Several species have been described, one of which was discovered in the sphagnum swamps of New Jersey, and from its resemblance to a butterfly, when the pseudopods or arms are extended, it has been named *Hyalosphænia papilio.* Pores were found to exist in the shell, through which the water passes in and out as the body dilates and contracts. Foreign substances adhere to the naked *Amœbæ* on the part of the body opposite to that from whence the pseudopods are protruded. A sluggish *Amœba* had been observed to swallow shelled *Rhizopods*, and, after digesting the soft parts, the shell was ejected. Others had been observed to select specimens of diatoms having green digestible matter in their interior from those which were not possessed of such nutritive material.

MIGRATIONS OF THE LEMMING.

The remarkable migrations of the lemming in Norway have long excited the wonder of observers; the precise impulse which induces this diminutive rat to take up this journey, always in a definite direction, being a problem of very difficult solution. Mr. Duppa Crotch has propounded a new view in explanation, which is ingenious, if not entitled to consideration. As is well known, these animals always move westward in their migrations, and finally, in diminished numbers, perish in the sea. In one instance a ship is said to have sailed for fifteen minutes through an army of them, the water being literally covered as far as the eye could reach. According to Mr. Crotch, this migratory instinct is hereditary from progenitors that in a past geological age dwelt in an island of plenty now submerged beneath the Atlantic. Although there is now no land to be reached, and the goal actually attained is the deep sea, it is supposed that the instinct of westward migration is inherited, and persists long after the cause of such migration has ceased to exist.—12 *A*, *June* 1, 1876, 113.

THE TRIASSIC FAUNA IN ILLINOIS.

John Collett, of the Geological Survey of Indiana, has recently discovered a number of remains of fossil vertebrata, which indicate the existence of a fresh-water formation of later age than has been heretofore supposed to exist there. The bones are those of lizards and fishes, two generic forms of each. The lizards are remarkable from their perforate vertebræ, causing them to be ring-like or tubular, as they are long or short. They represent the order *Rhynchocephalia*, which is abundant in the European trias, but is represented by only one living species, the *Sphenodon* of New Zealand. The fishes are a *Ceratodus* and a *Biplodus;* the former is also principally a genus of the trias, but, like the lizards of the same locality, has a living species in North Australia, the now famous Barrimundi. It is thus evident that the triassic fauna now represented in the southern hemisphere existed at an early geologic period not only in Europe, but in North America also.

REMAINS OF THE IRISH ELK.

Dr. A. Leith Adams communicates to *Nature* the particulars of the discovery of a large number of remains of head bones of the great Irish elk, *Cervus megaceros*, of which skeletons are now preserved in the museums of Cambridge, Yale, Philadelphia, Washington, and elsewhere in the United States. It is well known that this animal inhabited certain parts of Europe during the prehistoric period, and was especially abundant in Ireland, from which country most of the more perfect skulls and skeletons have been obtained. The frame of the animal was about the size of that of the American moose, the horns, however, much larger, although of somewhat the same shape, the distance from tip to tip in some cases being as much as twelve or fourteen feet. Zoologically the species is quite distinct.

The remains of these animals generally occur in peat bogs, and in 1847, while draining such a bog at Kellegar, among the Dublin mountains, as many as thirty heads were obtained in a cutting of about a hundred yards in length by three in breadth. Nothing further was done in this locality until, at the suggestion of Dr. Adams, during the present year, a renewed examination of the region was made by running a series of trenches parallel with the original ditch, which was done at the expense of the Royal Irish Academy. The result has been the finding of about thirty additional heads of the great Irish deer. These were imbedded in from two to three feet of clay, often lying on or impacted between blocks of granite, as if they had been drifted into that situation. Here, as elsewhere in Ireland, they were met with around the margins of the bogs, and not in the middle, as if the animals were mired in the shallow water, or else their carcasses had drifted with the winds and currents to the sides and outlet of the lake.

Another collection of a similar character has lately been dug from a bog on the property of Mr. R. Usher, of Cappogh, near Dungarvan. These were collected in a space about one hundred yards in length and seventy in breadth, and include heads and cast antlers of no less than fifteen individuals of the great horned deer and the antler of a red deer.—12 *A*, *September* 16, 1875, 435.

REVISION OF THE GLIRES.

Mr. Edward R. Allston has lately published, in the Proceedings of the Zoological Society of London, a revision of the order of *Glires* (*Rodentia*), or gnawing animals, in which he includes both the fossil and the recent forms. The whole paper promises to be of great benefit to working naturalists, based as it is upon an examination of the principal collections of these animals in Europe.

MARSH ON THE BRONTOTHERIDÆ.

Professor Marsh published in the April number of the *American Journal of Science* an account of one of the discoveries recently made by him in regard to what he calls the *Brontotheridæ*. This is a group of gigantic mammals abounding in the lowest deposits of the miocene formation in the eastern slope of the Rocky Mountains. They were of enormous size, and so peculiar in character as not to be referable to any familiar form of modern times. They possessed horn cores, which probably sustained horns resembling those of the deer. In size they equaled the elephant, but the limbs were shorter. The nose was probably flexible, as in the tapir, but without any true proboscis. All the known remains are from points east of the Rocky Mountains, in the miocene beds of Dakota, Nebraska, Colorado, and Wyoming.—4 *D*, *April*, 1876.

RAPID DESTRUCTION OF THE BUFFALO.

Some idea of the extent to which the extermination of the buffalo is going on at the present time may be learned from the fact that the Wilkox Tanning Company, of Elk County, Pennsylvania, said to be the largest of the kind in the world, and which is especially engaged in tanning buffalo-skins, received in the spring of 1875 120,000 bull-buffalo hides. These were all taken within a few months previous to the time of shipment, and constituted only a small portion of the entire number destroyed, which may be safely estimated at half a million. One thousand pounds of very heavy bullets were picked out, partly imbedded in the skin or matted hair of this stock of hides. Several of these bullets were sent to the Smithsonian Institution, and were exhibited at the Centennial display, illustrating the useful products of the United States as derived from the animal kingdom.

GEOGRAPHICAL VARIATION AMONG NORTH AMERICAN MAMMALS, ESPECIALLY IN RESPECT TO SIZE.

The fourth number of the second volume of the Bulletin of the Geological and Geographical Survey of the Territories is occupied by several zoological papers by Mr. J. A. Allen, of Cambridge. The most important of these is one upon "The Geographical Variation among North American Mammals, especially in respect to Size."

Referring to the generalization that was made some years ago, that the American mammals as well as birds increase in size with the latitude of their birth-place, as also with altitude, Mr. Allen remarks that this does not apply in the case of some of the carnivora, and that the following propositions more nearly express the fact: 1. The maximum physical development of the individual is attained where the conditions of environment are most favorable to the life of the species. 2. The largest species of a group (genus, sub-family, or family, as the case may be) are found where the group to which they severally belong reaches its highest development, or where it has what may be termed its centre of distribution. 3. The most "typical" or most generalized representatives of a group are found also near its centre of distribution, outlying forms being generally more or less "aberrant" or specialized.

FOSSIL ELEPHANTS, DOGS, AND DEER OF NEW MEXICO.

Professor Cope has called the attention of the members of the Philadelphia Academy of Sciences to certain mammalian remains from the neighborhood of Santa Fé. The specimens exhibited belonged to the *Mastodon productus*, which must have been very abundant in that region. The speaker dwelt upon the peculiarities which distinguished it from *Mastodon Ohioticus*, and gave at length the characters of the dentition. The vertebrates found in the Santa Fé marl now number thirty-two, including eleven species of *Canis*. These are all extinct, with the exception of one species of wolf, the *Canis cœvis* of Leidy. This was believed to be identical with the living wolf, which was considered to be specifically identical with the common dog. The species mentioned originated in the Upper Miocene, and persists to the present day. A new form was described under the name of *Canis wheelerianus*. The number of species of fossil deer found in the formation spoken of was increased from four to six, the two new forms being named *Dicrocerus trilateralis* and *Dicrocerus tehuanus.—American Naturalist, October.*

NEW EXTINCT WOLF AND DEER FROM THE UPPER MISSISSIPPI.

Many years ago Professor J. D. Whitney made a collection of the bones of fossil mammals from the lead-crevices and superficial strata of the lead regions of Wisconsin, Iowa, and Illinois, a part of which were enumerated by the late Professor Jeffries Wyman in "Whitney's Geological Report of the Lead Region of the Upper Mississippi," published in 1862. The collections comprised the bones of the *Mastodon*, *Megalonyx*, and *Platygonus*, an extinct species of *Bison*, an extinct peccary, and now Mr. J. A. Allen describes from the same collection a deer, under the name of *Cervus Whitneyi*, and a wolf, with the appellation *Canis Mississippiensis*. Nearly all these remains belong to extinct mammals and to the fauna immediately preceding the present.—*Amer. Jour. of Science and Arts*, *January*, 1876.

PROBABLE EXTINCTION OF THE ELEPHANT.

M. Hayaux du Tilly states that England alone imported annually 1,200,000 pounds of ivory, and to obtain this quantity it was necessary to kill annually 30,000 elephants, and the ivory supply of the whole world probably caused the destruction of 100,000 elephants annually, and, as females and males were killed indiscriminately, this animal would soon become extinct.—*American Naturalist*, *November*, 1876.

A NEW CALIFORNIAN DEER.

A very pronounced variety of the mule-deer (*Cervus macrotis*) has been discovered by Judge Caton in the Sierra Nevada Range. It differs from the ordinary mule-deer chiefly in the markings of the tail, a dark line extending down the upper side of the tail uniting with the black tuft at the end, while the tail of the normal mule-deer is entirely white except a dark tuft of long hairs at the extremity.—*American Naturalist*, *August*, 1876.

A NEW PORPOISE IN NEW YORK BAY.

Under the name of *Phocæna lineata* Professor Cope describes a new species of porpoise which was taken in the harbor of New York not many months ago, and sent to the Smithsonian Institution. Under the direction of Professor Baird, a plaster cast of the animal was made and colored directly from the specimen, with the excellent result of offering a means of study more reliable than the dried skin, where the form is likely to be distorted from various causes, and the color changed by the action of the oil.—*Proc. Acad. Nat. Sci.*, *Philadelphia*, 1876.

COLORING MATTER OF THE EGGS OF BIRDS.

Mr. H. C. Sorby, who has distinguished himself by his spectroscopic and chemical investigation of the coloring matter of leaves, has lately rendered a similar service in reference to the coloring matter of the egg of the bird, in a paper presented to the Zoological Society of London. He remarks that, although the eggs of the bird appear to be of almost unlimited variety, all this apparent confusion is due simply to a variation in the relative and total amount of a limited number of definite and well-marked substances.

Previous to his inquiry, the only suggestions made in regard to this matter of color were that the redder tints were due to altered blood, passing through the swollen vessels of the oviduct, and that both the redder and greener tints are due to bile pigments, and perhaps derived from the fæces in the cloaca. Mr. Sorby, indeed, finds good physical evidence to prove that the characteristic coloring matters in eggs are closely connected either with hæmoglobin or bile pigments, but not in the manner suggested by previous writers. He thinks that the coloring of the eggs is due to definite physiological products, and not to accidental contamination with substances whose function is altogether different.

So far Mr. Sorby has found seven well-marked substances, one identical with a coloring matter met with in nearly all groups of plants, from the lowest to the highest; the rest he has not been able to identify with any found elsewhere. All these seven substances are insoluble in water, but soluble in absolute alcohol, and sometimes in chloroform or carbon bisulphide. Some are extremely permanent, and resist the action of powerful reagents; others are so unstable that they are not only rapidly changed by acids and other agents, but are even partially decomposed by evaporating their solutions to dryness at a gentle heat.

The method adopted by Mr. Sorby in his inquiries was to actually separate the coloring matter from the shell, by various processes detailed by him, as they were subjected to various critical chemical examinations. The substances found by him are as follows:

First, *Oorhodeine.* This he considers as the most important and interesting of all the coloring matters, a very small quantity being recognized without any difficulty even when mixed with a large amount of colored impurities. It also occurs, in a larger or smaller amount, in the shells of so great a number of eggs that its entire absence is exceptional. In a free *solid* form, as in the shell, it is generally of a peculiar brownish red.

Second, *Oocyan.* This when dissolved in alcohol is of a fine blue color. It is readily soluble in neutral alcohol, and thus can be separated from oorhodeine. It is, however, often associated with yellow substances that can not be easily removed.

Third, *Banded oocyan.* This is also of a fine blue color, but differing very decidedly in its spectrum from oocyan.

Fourth, *Yellow oöxanthine.* This may best be obtained from moderately fresh emu-eggs.

Fifth, *Rufous oöxanthine.* This, so far, has only been found in the different species of Tinamon.

Sixth, *Substance giving narrow absorption bands in the red.* This Mr. Sorby has not been able to separate in sufficient quantity to determine whether its real color is blue, green, or brown.

Seventh, *Lichnoxanthine.* This occurs in greater or less amount in almost all classes of plants, and is most especially abundant in the lichens and fungi. Mr. Sorby thinks this may possibly have been derived, to a certain degree, from the decayed vegetable matter of the nest, or, in cases of eggs which have been kept long, may be partly due to the growth of minute fungi; but, at the same time, a very closely allied, if not identical substance, does really appear to be a normal constituent of the shell of eggs having a peculiar brick-red color.

In reference to the colors of eggs, Mr. Sorby remarks that the varying tints are due to the presence of either of these primary coloring matters, and this in a separate condition, or mixed to a greater or less degree with others. Thus the various shades of green, passing from blue-green to a fine malachite-green and to a yellow-green, are due to a variable mixture of oocyan with yellow oöxanthine. It is well known that many green eggs turn blue on long keeping. This is explained by the fact that yellow oöxanthine is much more easily destroyed by oxidation resulting from exposure to light than oocyan, the oocyan or the blue color remaining unchanged.

Mr. Sorby thinks that it will be very difficult to make use of the spectroscopic character of the coloring matter of eggs in determining their species, or even their genera, especially in view of the fact that in some eggs, as in the Guillemot, the variation in the series is so great, sometimes one tint prevailing exclusively, and in others several, or possibly all of them, combined. He concludes by stating, as a summary of his inquiries, that he considers the chief points to be that all the varied tints of birds' eggs are due to mixtures of a limited number of coloring matters having well-marked specific characters. Except in one particular case there is apparently no intimate connection between the organization of the birds and the coloring matters secreted; but if further inquiry should prove that on the whole these substances are formed naturally only during the development of the eggs of birds, it would be an important fact in relation to comparative physiology and chromatology, as showing that special colored substances are secreted under special anatomical and physiological conditions, as does indeed occur in the case of many other normal and abnormal secretions.—*Proceedings of the Zoological Society, London*, 1875, 351.

ON THE MANAGEMENT OF AQUARIA.

A valuable paper on the construction, management, and utility of aquaria, by Mr. W. Saville Kent, has been published in the Journal of the Society of Arts, in which the latest views in reference to the best mode of managing the water are brought forth. Here, as in previous communications, Mr. Kent insists upon the propriety of using the same water over and over again, especially for fresh-water tanks, urging that the perfection of the water by the deposit of all its sedimentry particles, and its more thorough combination with air and its oxygen, is better effected than by allowing a continued stream of freshly pumped sea-water or fresh water from springs.—23 *A*, *March* 3, 292.

PECUNIARY SUCCESS OF THE BRIGHTON AQUARIUM.

The pecuniary success of well-managed public aquaria is shown by the report of the Brighton Aquarium Company. In this it is stated that the sum of £12,310 11*s.* 7*d.* is available on dividend account. A dividend at the rate of ten per cent. per annum was paid in July last, and a second dividend has now been ordered from the present profits, leaving a balance of £5446 to be carried forward.

The Aquarium Company has been lately the subject of proceedings in court on account of its violation of certain enactments in keeping open on Sunday. This has now been compromised by opening on Sundays during certain hours, and as an aquarium only, the other exhibitions being omitted. —2 *A*, *Feb.* 12, 1876, 134.

PHOTOGRAPHS OF THE BLOOD.

Mr. G. Gulliver, F.R.S., one of the greatest living authorities on the subject of blood corpuscles, has spoken in the highest terms of the photographs of Professor T. G. Wormley and Dr. G. Richardson, exhibiting the human blood disks compared with those of the pig, cat, dog, etc.; and he expresses the hope that American physiologists will continue these valuable representations, especially as the subject seems to be almost ignored in Europe.—*Monthly Microscopical Journal*, *July*, 1876.

CARRYING HUMBLE-BEES FROM ENGLAND TO NEW ZEALAND.

A further step in the progress of the international exchange of animals has just been made in the transmission to New Zealand, by Mr. Frank Buckland, of two nests of English humble-bees. The common English clover, which has been introduced into New Zealand and Australia, has not produced seeds in proper quantity, due, as is supposed, to the fact that, as bees perform a large portion of the labor of the fertilization of such plants, the proboscis of the common bee is not long enough to reach down to the pollen of the clover flower, which the humble-bee is enabled to do.—12 *A*, *Oct.* 14, 1875, 527.

NEW AQUARIUM AT WESTMINSTER.

The new aquarium at Westminster, which probably is justly entitled to the claim of being the largest and most magnificent establishment of the kind in existence, was opened toward the end of January for concert purposes, but the tanks were not in a condition for being filled with water. Among some special features of its construction is an arrangement that the overflow of water from one tank will pass down a tube so as to enter the next tank at the bottom, causing a continued displacement of the water already in the tank. The reservoir, which occupies the space under the large hall, is divided into nine compartments, so that in case of accident to any part, it can be cleared of the water and repaired while the other sections remain in operation.

The total capacity of the reservoir is 600,000 gallons, and the total amount of water in the reservoir and tanks together will be 750,000 gallons. For the circulation eight rotary vulcanite pumps are erected, which are capable of sending 56,000 gallons through the tanks in an hour if needed, though it is calculated that 15,000 to 20,000 gallons will be the average amount. The salmon will have a fifty-feet run. All the pipes, culverts, etc., are of vulcanite, but the glass fronts of the tanks are fitted in cork.—*January* 27, 1875, 255.

DECREASE OF BIRDS IN MASSACHUSETTS.

There are, says Mr. J. A. Allen, few data obtainable relative to the subject of the extinction of our birds. The number of indigenous species belonging to the fauna of the state is about 310. Of these, two, the Great Auk (*Alca impennis*) and the Wild Turkey, have become wholly extirpated, and two others (the Pinnated Grouse, *Cupidonia cupido*, and the American Swan, *Cygnus americanus*) are so nearly so that the former is found at only one or two limited localities, and the latter is but a chance visitor. The Brown or Sand-hill Crane (*Grus canadensis*), and perhaps a second (the White or Whooping Crane (*Grus americanus*), were formerly inhabitants of the state, though extirpated at so early a date that they have not as yet been recognized as belonging to its fauna. Among those which have greatly decreased in numbers are the Red-winged Blackbird (*Agelæus phœniceus*), the Purple Grackle (*Quiscalus purpureus*), the Crow (*Corvus americanus*), the Raven (*Corvus corax*), the Pileated Woodpecker (*Hylotomus pileatus*), the Red-headed Woodpecker (*Melanerpes erythrocephalus*), the Wild Pigeon (*Ectopistes migratorius*), and the Snow Goose (*Anser hyperboreus*). To these, says Mr. Allen, might be added, as among those which have also notably decreased, most of the wading and swimming birds, and nearly all of the rapacious species. None of the ducks and geese, and probably few of the limicoline species, are probably *one tenth* as numerous now as they were 250 years ago, while a great depletion has also occurred among the gulls and terns. This great diminution is, of course, not limited to the state of Massachusetts, but likewise characterizes most of the Atlantic states and some of the older states of the interior. The reduction has mainly been brought about by the destruction of forests, the progress of agriculture, and the excessive use of the gun.—*Bulletin Nuttall Ornithological Club, September.*

CATALOGUE OF ALL THE BIRDS KNOWN UP TO THIS DAY.

For three years M. Boucard has had this volume in preparation, which has been published in London. 2456 genera and 11,030 species of birds are mentioned, though he thinks a large proportion of these genera and species should be abolished. The catalogue begins with the Ostriches, as he believes that they approach most closely fossil types, while the Trochilidæ are the most recent, and perhaps the most perfect. He proposes a good many changes, among others three new orders. While he enumerates the names of leading European ornithologists from Linnæus down to Gulliver, no American name is mentioned in the preface. He says that he has examined more than 100,000 skins, and determined more than 50,000, of which he possesses the greater part.—*Journal de Zoologie*, V., No. 4.

DOMESTICATING THE PRAIRIE CHICKEN.

According to Mr. James A. Storm, of St. Josephs, prairie chickens, or pinnated grouse, are more easily tamed than any birds of his acquaintance. He has had them eat from his hand in the space of five or six days from the time they were caught. They will also breed while confined, if provided with a suitable run. He proposes this year to try the experiment of domesticating and breeding them, and thinks they can be raised to great advantage. One object of his experiment is to obtain a cross between them and the bantam. This, he thinks, will give the bantam more stamina and hardness, making it less liable to disease, as well as tending to keep it of the diminutive size so much sought after. If crossed by the Dominique bantam, he thinks the original markings of the prairie chicken will be thereby retained.

ADDITIONAL REMAINS OF THE MOA.

It is probable that the gigantic fossil bird of New Zealand, known to the natives as the Moa, and scientifically as the *Dinornis*, *Palapteryx*, etc., will become a very common object in natural-history museums, as new discoveries of bones in large number are continually being made. The latest record is that of fifteen specimens found along the beach, about sixty miles to the north of Auckland, a more northern location than has hitherto been assigned to this group. With the bones were found several human skulls and a complete human skeleton, a rude stone hatchet, and some obsidian chips, etc., furnishing another confirmation of the well-established fact of the co-existence of the Moa with man. It will, perhaps, be remembered that among the most interesting objects in the American Museum of Natural History, in the Central Park, is a series of skeletons of this bird, procured from Dr. Julius Haast, of Christchurch, New Zealand.—12 *A*, *February* 3, 273.

THE MIGRATION OF BIRDS.

During the cold period which lasted from the 12th of December, 1874, up to the end of that month, it was remarked in England that a great number of birds belonging to species which are not in the habit of leaving their own country were found collected, as if they meditated seeking a milder climate. Unusual flights of migratory birds were equally noticed. Evidently these birds were endeavoring to escape from the temperature which was too severe for them. A comparison of the observations of naturalists with the weather-charts published in Europe and America makes it now seem certain that the weather immediately prevailing, and not that which is about to come in the near future, is the element which decides the movement of the greater number of migratory birds.

FOSSIL BIRDS IN AMERICA.

Professor Marsh continues to find objects of interest in the immense collection of fossil vertebrates gathered by himself and his employés in the West during the past ten years. We have already referred to his discovery of a new form of pterodactyl, characterized by the entire absence of teeth, and their probable replacement by a horny sheath like that of the bill of modern birds.

He now announces two additional fossil birds possessing teeth implanted in sockets. One is a new species of the first division, *Hesperornis*, and the other forms the type of a new genus, *Lestornis* (*L. crassipes*), the remains of which indicate a large swimming bird, fully six feet in length from the bill to the end of the toes.—4 *D*, *June*, 1876.

ADDITION TO NORTH AMERICAN ORNITHOLOGY—PYRRHOPHŒNA RIEFFÈRI.

A few years ago the only species of humming-bird known with certainty to occur within the limits of the United States were the ruby-crowned, of Eastern North America, and the rufous or Nootkan hummer, of the Pacific coast. Since then quite a number of additions have been made by Mr. Xantus, Captain Feilner, Dr. Heerman, Mr. Henshaw, and others, a number of these being species occurring in Mexico, and detected across the United States border. The most recent addition of the kind is in the discovery by Dr. Merrill, of the United States army, in Texas, of *Pyrrhophœna rieffèri*, taken not far from Brownsville.

There are about thirty species of humming-birds known to occur on the table-lands of Mexico, nearly all of which will be found to belong to the fauna of the United States.

THE HABITS OF BIRDS.

Ornithology has advanced greatly in this country during the past few years, and one of its longest strides has been in the direction of a knowledge of the migrations of birds, and of the causes which bring about these seasonal and united movements. But to ascertain what influences act with most force much more information is necessary, collected over wide areas and through successive seasons. *The Forest and Stream* suggests a series of points upon which observations, to be published, are especially useful and desirable. The queries are expected to bring replies that shall give the comparative abundance of birds in the observer's region, the dates of arrival, departure, nest-building, laying of eggs, and hatching of young; the effect upon the relative abundance of particular species in retarding their arrival or hastening their departure that sudden changes of the weather, storms, and early and late seasons appear to have; and parallel notes upon the appearance of the quadrupeds, fishes, and reptiles of the region, and upon the times of flowering of plants, are also solicited. The importance of collecting such data is evident; when a sufficient amount of them is accumulated students will have the material for new advances in biology.

NEW FOSSIL GIANT BIRDS.

Professor Marsh continues his important articles upon the fossil vertebrates of the United States in a paper, printed in the *American Journal of Science*, upon the *Odontornithes*, or birds with teeth, in which he reviews the characters of certain genera, as *Hesperornis*, *Ichthyornis*, and *Apatornis*. He gives the group the rank of a sub-class characterized by the possession of teeth implanted in the jaw, and arranges them in two orders—the one, *Ichthyornithes*, with teeth in the sockets, vertebræ biconcave, sternum with keel, and wings well developed; the other, *Odontolcæ*, with teeth in grooves, vertebræ as in recent birds, sternum without keel, and wings rudimentary. The last-mentioned order has as its type the genus *Hesperornis regalis*, which was of gigantic size, the length from the apex of the bill to the end of the toes being between five and six feet. The rudimentary wings prove that flight was impossible, while the powerful swimming legs and feet were peculiarly adapted to rapid motion through the water. The tail appears to have been much expanded horizontally, as in the beaver, and doubtless was an efficient aid in diving, perhaps compensating for the want of wings, which the penguins use with so much effect in swimming under water.—4 *D*, *June*.

A TAME SERPENT.

A curious history is given by Mr. Buckland in *Land and Water* of a pet boa-constrictor, seven and a half feet in length, belonging to Mr. Mann, and which had become warmly attached to that gentleman and his wife, evincing its affection in the most decided manner. In one instance the snake had been left for about six weeks in charge of a friend, and during this interval it was very quiet, and moped a good deal, as if missing its protectors. On their return, while still invisible to the snake, when its name was called by Mrs. Mann, it sprang forward with the greatest eagerness, and wound itself around her shoulders, caressing her in the most excited manner, and then moved to Mr. Mann, and twisted itself around him under his coat, but in neither case exerting any uncomfortable pressure.

The supposed cause of the death of this serpent is almost as curious as its manners in life, and is related by Mr. Mann as follows: During his own serious illness he was confined to his bed, and unable to respond to the caresses of the serpent. After a failure or two on its part to secure its accustomed attention, it retired to its bed, and, refusing food and water, died in a day or two, and as Mr. Mann believed verily from distress. Many interesting facts are given by Mr. Mann in regard to this remarkable serpent, who states that, although he has had many pets of different kinds, and some of them tolerably clever, he had never seen any animal that could compare with this boa for affection, quick sense, and good-humor.—2 *A*, *June* 10, 42.

NEW ORDER OF PTEROSAURIA.

Professor Marsh, in the June number of the *American Journal of Science*, gives an account of a new order of Pterosauria, or winged saurians, embracing the pterodactyls. He finds, on examination of the specimens obtained by him in 1871 and 1872, that they really are not the equivalents of the pterodactyls of Europe, as they differ therefrom in the absence of teeth. In his opinion the jaws were probably incased in a horny covering like that of the bills of birds. In several other respects the jaws of this genus are more like those of birds than of any known reptiles.

The vertebræ are similar to those of European pterosaurians, and the atlas and axis are united. There are four phalanges in the wing finger, and the metacarpal that supports it is longer than one half of the fore-arm.

The head of one of the species of this new genus, which he calls *Pteranodon longiceps*, has a length of thirty inches from the occipital crest to the end of the premaxillary. The smallest American species is considerably less in size. The specimens referred to are from the upper cretaceous of Western Kansas. It is considered an interesting fact by Professor Marsh that the localities and geological horizon of these specialized, toothless pterodactyls are precisely the same as those of the *Odontornithes*, or birds with teeth, and the two doubtless lived together in the same region.—4 *D*, *June*, 1876.

A FOSSIL REPTILE WITH MAMMALIAN CHARACTERS IN PRINCE EDWARD ISLAND.

In a paper by Professor Owen on the former existence of Theriodont reptiles in the Ural Permian deposits as well as in South Africa, he states his belief that Leidy's *Bathygnathus borealis*, from the red sandstone, "probably of Permian age," in Prince Edward Island, was a Theriodont allied to *Lycosaurus* of the karoo beds of South Africa. Similar fossils from the Ural region had been described in 1838 by Kutorga as probably mammalian. Similar animals occurred in the conglomerates at Bristol, England.—*Ann. and Mag. Nat. Hist.*, *August.*

REPTILES OF COSTA RICA.

Professor Cope has published an important paper on the *Batrachia* and *Reptilia* of Costa Rica, with notes on the reptiles of Nicaragua and Peru, in the quarto journal of the Philadelphia Academy of Natural Sciences. Most of the Costa Rican materials were obtained from the researches of Dr. William M. Gabb, who was engaged for several years in exploring that country in behalf of the Costa Rican government, by which he has added very largely to our knowledge of the geography, geology, general natural history, and ethnology of the region. He has already published many papers in all these departments, and it is to him we owe our only reliable information in regard to the Costa Rican aborigines. The first series of all the collections made by Dr. Gabb have all been presented by him to the National Museum, in Washington, and they constitute a highly valued portion of the extensive collections of the establishment.

Other collections used by Professor Cope in this memoir are those of Dr. Van Patten and Mr. C. N. Riotti, these covering the region extending from the Atlantic to the Pacific. Eighty-nine species were furnished by Professor Gabb, of which thirty-seven were new to science. The total number of species known from all investigators in Costa Rica is one hundred and thirty-two, and it is probable that a large number yet remain to be discovered, showing that the region is rich in terrestrial cold-blooded vertebrates.

SNAKE-EATING SNAKES.

Some years ago Professor Cope described the snake-eating habits of *Oxyrrhopus plumbeus*, a large snake which was observed to have swallowed the greater part of a large *fer-de-lance*, the largest venomous snake in the West Indies. More recently a specimen was brought by Mr. Gabb from Costa Rica, almost five feet in length, which had swallowed three feet of a large harmless snake (*Herpetodryas carinatus*) about six feet in length. Still more recently Dr. J. G. Cooper records the fact that in California a garter-snake was swallowed whole by a milk-snake (*Lampropeltis boylii*). The two snakes were so nearly of a size that he did not, at a casual glance, notice any difference between them; the garter-snake was over two feet in length.—*Am. Nat.*, *Mar. and Aug.*, 1876.

REMARKABLE HABIT OF FROGS.

Professor Peters has recently described the mode of laying its eggs employed by a species of tree-frog (*Polypedates*) from tropical Western Africa. This species deposits its eggs, as is usual among batrachians, in a mass of albuminous jelly, but instead of placing this in the water, it attaches it to the leaves of trees which border the shore and overhang a water-hole or pond. Here the albumen speedily dries, forming a horny or glazed coating of the leaf, inclosing the unimpregnated eggs in a strong envelope. Upon the advent of the rainy season the albumen is softened, and, with the eggs, is washed into the pool below, now filled with water. Here the male frog finds the masses, and occupies himself with their impregnation.

REPRODUCTION IN THE PROTEUS.

It is not a little remarkable that until recently nothing was known of the mode of reproduction of the *Proteus anguineus*, a salamander-like animal living in the subterranean waters of the caves of Carniola, in Austria, and characterized among its congeners by the absence of eyes, and as possessing other peculiarities. Quite lately, however, Mr. Franz E. Schulze has published in Kölliker's *Zeitschrift* an article on this subject, in which he remarks that while at Adelsberg in September last, he heard that the Proteus in possession of the keeper of the caves had laid eggs. He made an examination of the specimens referred to as preserved in alcohol, and then established their character by a dissection of a gravid female, and now reports that the number of eggs laid is between forty and fifty, and that they are about five millimeters in diameter. Although the eggs were kept in water after being laid by the female, no special development seems to have taken place, and consequently nothing has yet been ascertained about their interior structure. It is probable, now that attention has been directed to this subject, it will not be long before all the phenomena in regard to the species, which doubtless embrace some interesting peculiarities, will be brought to light. The egg, as represented in the drawings, is about the size of that of a salmon.—36 *C*, XXIV., 350.

HABITS OF THE MEXICAN AXOLOTL.

In a letter to Mr. Henry Lee, published in *Land and Water*, Captain Mayne Reid suggests some new ideas in regard to the occurrence of the axolotl in the lakes of Mexico. This species resembles the larval or immature condition of many American salamanders, especially those occurring under logs in damp places. Much interest has attached to this animal from the fact that, although in its native waters, at the altitude of the City of Mexico, it always remains in the larval condition, laying eggs and reproducing its kind, yet when individuals were taken to Paris, many years ago, they threw off their gills, and became transformed into true salamanders, living out of the water, and developing a totally different and much more brilliant style of coloration, with other changes in regard to the lungs, the teeth, and entire anatomy.

The special object of Captain Reid's letter was to express astonishment that descendants of the real axolotl were kept in fresh water in the Brighton Aquarium, whereas they occupy the Lake Tezcoco—a body of water so salt that even fish can not live in it.—2 *A*, *March*, 1876, 180.

SPERMATOZOA OF AMPHIUMA.

Dr. Christopher Johnston, of Baltimore, has made some interesting observations on the very large spermatozoa of *Amphiuma tridactylum*. The length of these was about $\frac{1}{85}$ of an inch. From the junction of the head with the body to the extremity of the tail was a double filament, in lively motion, so that a delicate spiral seemed to wind from the head to the caudal termination so long as the zooid was free; but the motion was instantly reversed as soon as the head became attached or entangled. When at rest, the spiral resolved itself into a most delicate, undulating membrane. The red corpuscles of the blood of the *Amphiuma* rival in size the spermatozoa, being $\frac{1}{324}$ of an inch in their larger axis, and $\frac{1}{571}$ of an inch in their conjugate diameter.—*Monthly Microscopical Journal*, *May*, 1876.

RESEMBLANCES OF PLESIOSAURS AND ICHTHYOSAURS TO OTHER VERTEBRATES.

Professor H. G. Seeley points out, in an extended article in the Journal of the Linnæan Society, not only the relation in the bones of these fossil gigantic reptiles to those of other orders of reptiles, fossil and extinct, but also their similarity in certain features to birds and even mammals.

RAFINESQUE'S FISHES OF THE OHIO.

The work of Rafinesque, entitled "Ichthyologia Ohioensis," etc., has become so rare, and his labors so generally overlooked, that Professor D. S. Jordan has published a paper in the Bulletin of the Buffalo Society of Sciences (vol. iii., No. 3, 1876), giving a list of the genera, sub-genera, and species described in this work, with the names which they should in Mr. Jordan's opinion now bear. This is of special importance, as Rafinesque's names for our fishes have priority of date over those of almost all other authors who have written on the ichthyology of our inland waters, except Lesueur.

THE PILOT FISH.

That the stories concerning this fish are true is reaffirmed by Mr. A. H. Burnell, who says that eleven years ago, while on a voyage from India to this country, his vessel was beset by many calms while crossing the " line." On one of these occasions, while some of the passengers were amusing themselves looking over the stern of the vessel, two beautiful pilot fishes (Naucrates?) were seen, and soon after a portion of an unusually large shark. Immediately a hook baited with salt pork was thrown overboard. When it touched the water these pilot fishes were seen to approach it, and then suddenly dart under the vessel. Soon a very large shark appeared and received the bait. As soon as safely secured the sailors drew him on deck. When a suitable opportunity was given for examining him, these two pilot fishes were seen attached to the body. At what particular portion they attached themselves he was unable to state. They were removed and placed in a bucket of salt water, where they swam about as if nothing had happened.—*Am. Natural., Nov.*, 1876.

NEW WORK ON EUROPEAN FRESH-WATER FISHES.

Professor Von Siebold, the eminent zoologist of Munich, is about publishing a great work on the fresh-water fishes of Europe, in which he invites the co-operation of English naturalists. He also desires specimens of *Artemia salina*, or the salt-brine shrimp, for the purpose of making comparisons with the varieties of this genus found throughout the world. A work upon the fresh-water fishes of the United States, corresponding to those of Europe, is a very great desideratum, and it is much to be hoped that some of our naturalists may undertake this labor before long.—12 *A, March* 7, 1876, 306.

SOME CURIOUS AUSTRALIAN FISHES.

The interest that attaches to the Australian fish known as the *Ceratodus* (*C. forsteri*) is well known to naturalists. M. Castelnau, in Gervais's *Journal of Zoology*, calls attention to several other Australian species of equal interest. These are the *Neoceratodus blanchardi* and the *Osteoglossum leichardti*.

The *Ceratodus forsteri* attains a length of six feet, and its flesh is said to be excellent and rather red, on which account it is called the Burnett salmon. It is quite restricted in its habitat, having only been met with in the Burnett and the Condamine Rivers. The *Osteoglossum leichardti* reaches a weight of twenty-five pounds. The fish is very handsome, and is taken with the hook. The *Neoceratodus blanchardi* is something like the *Ceratodus*, but differs in the structure of the teeth. It is found in the River Fitzroy, and attains a weight of from forty to ninety pounds.

The rivers in which this fish is found become almost dry at certain seasons of the year, and it is still a problem what becomes of them, although it is suggested by some that they bury in the mud, and remain there until the return of water. —14 *B*, II., 1876, 129.

POEY'S CATALOGUE OF CUBAN FISHES.

Professor Felipe Poey, the veteran Cuban ichthyologist, has recently published a catalogue of the species of that island, in which he enumerates seven hundred and thirty species. Of these, seventy-eight are considered somewhat doubtful, leaving six hundred and fifty-two. Of these, sixty-four will probably prove to be undescribed, but the determination of this will depend upon further researches and comparisons.

HABITS OF THE SALMON.

Mr. Henry Lee has lately published some of his observations on the salmon in the Brighton Aquarium in the London *Field*, which throw much light upon some of the vexed questions in regard to the natural history of this noble fish. He states that in April, 1873, nine salmon smolts, taken in the Usk River on their way to the sea, were placed in the aquarium. These were kept in tanks, some of them in fresh water, to which salt was afterward added gradually; the others were placed directly in the salt water, the latter apparently sustaining the change better than the others. Most of these fish died after a short time; two, however, remained, which were fed on shrimps and minced fish, and grew so fast that their increase was appreciable day by day. At the end of twelve months after their receipt, or, in April, 1874, only one survived, and this fish for a time ceased to grow, and was supposed to be pining for the fresh water. It was, however, still retained in the salt water; and in May it recovered its appetite, and fattened up greatly without increasing in size. In September it again refused food, and by the middle of February, 1875, had dwindled away considerably in size and condition. Afterward it began to feed again, devouring a whole herring, chopped up for it, at a single meal.

The fish did not grow very much during the year 1875, probably requiring a larger range of water for its proper condition. The inferences derived by Mr. Lee from these facts are that smolts, going to the sea, weighing two ounces, or thereabout, return from their first migration as grilse in a little more than a year, weighing from three to five pounds; that they can exist for at least three years in the sea without ascending a river, although probably a return to the latter is necessary for its continued and more healthy growth. He also concludes that from the end of the first year to that of the fourth they feed more heartily and grow more rapidly, and are in better condition at one season than another.

Mr. Lee also remarks that the salmon never takes its food below the plane of its own position in the water, and that when shrimps and portions of fish are thrown into the tank, it will rise to meet them as they sink toward it, but will not follow any portion that has sunk below its level, nor will it feed on the bottom, in this respect being very different from the sea trout in the same tank, which rummage along the bottom for food, and pick up shrimps and pieces of fish lying there.

THE RAINBOW FISH.

The peculiarities in the nesting and hatching out of the eggs of fishes constitute one of the principal elements of interest in their study, and almost every day some variations from the established method is brought to light. One of the most remarkable instances in this respect is that presented by a small fish of the genus *Macropus*, found in the marshes and ditches along the Ganges, known in India as the *Colisa*, and called by the English the *rainbow fish*. It is characterized by its brilliant colors, and by the presence of a long filament substituted for the ventral fins. Some curious facts have lately been given by M. Carbonnier as to the nesting of this animal. Seizing a little conferva plant with his mouth, the male raises it to the surface. Left there, the plant would sink, but the fish emits some air bubbles, and places them under it as a support. Repeating the process several times, he thus produces the first day a small floating island, about three meters in diameter. Next day he continues the supply of air, and accumulates the bubbles toward the central part, the effect being to produce a sort of dome, balanced on the surface. He then makes a rim for it with the same materials—plants and bubbles—and, going inside, he smooths and softens the interior surface. The female is then solicited to enter. The eggs are first deposited in a concave fold of the dorsal fin of the male, where they are fecundated. After laying her eggs, the female withdraws, leaving to the male fish the education of his family. He deposits the eggs with care separately in the raised part of the nest. At a later period, when he sees they need a different medium and treatment, he rises in the middle of the dome and bursts it, letting the bubbles escape, whereupon the structure flattens in the water with the imprisoned embryos, which are beginning to appear in a new stage of existence. To prevent their escape, he tears the flat rim of the nest into a sort of hanging fringe. For some time he exercises great surveillance over the progeny, till their frequent escapes and excursions announce the end of his fatigues, which occurs some eight or ten days after the flattening of the nest.—1 *B*, *Jan.* 2, 1876, 198.

INCUBATION OF CHROMIS PATERFAMILIAS.

Among the various abnormal methods of incubation, none are more curious than the habit of certain fishes of the cat-fish family of keeping the eggs in the mouth until the young are hatched, this act being generally performed by the male. Quite recently M. Lortét has added to the list the *Chromis paterfamilias*, as observed in a stream near the borders of the Sea of Tiberias, and not far from the ancient Capernaum. In this case the female deposits her eggs in a sandy depression in the bed of the stream, and the male sucks them into his mouth, and by some peculiar action causes them to be interpolated between the plates of the gills, where they are held without disturbance. The period of incubation is not mentioned, but the young, when hatched, leaving the gills, pass forward into the cavity of the mouth, where they remain closely packed, heads forward, the cheeks of the parents swelling out as the young increase in size, and presenting a most singular appearance. A few of the young sometimes remain between the branchial plates, but most of them pass forward as stated. M. Lortét did not ascertain at what period the young left the mouth of the parent, but presumed that they remained there a considerable time. Whether, after they once leave, they re-enter for protection, is not stated. It is very remarkable that the young are not swallowed by the parent while in their receptacle.—6 *B*, *December* 13, 1875.

CAUSE OF THE BLACK SPOTS ON THE SCALES OF FISH.

The abnormal occurrence of black spots or specks upon the scales or external surface of fishes has frequently been observed, and quite often mistaken for regular coloration. Dr. Fatio, of Geneva, however, has been investigating some of these cases, and finds that in nearly all of them a small parasitic worm occupies the centre of this spot, and is easily observable by the microscope. This is inclosed in two cysts, with a peculiar liquid between, the inner being oval and transparent, and the outer round, with thick fibrous walls, outside of which is the mass of star-shaped pigment cells. The further stages of this worm have not yet been worked out, although it is quite probable that when the fish is devoured by its predaceous neighbors, this enters into another stage of the alternations of generation which have become so familiar of late years to investigators.—18 *A*, *March* 19, 1875, 10.

REMARKABLE STRUCTURE OF YOUNG FISHES.

Dr. Gunther, of London, has recently discovered that the young of the sword-fishes and chætodons possess structures exceedingly different from that of the adults. In the young chætodons the front of the body is shielded with large bony plates, which in one species are produced into three long equidistant horns, which diverge ray-like from the body. In the sword-fishes the scapular arch is prolonged into a horn at the lower part, and the belly fins are wanting. There is no sword, but the jaws are long, of equal length, and both are furnished with teeth. As the fish grows, the scapular horn disappears, the ventral fins grow, and the upper jaw is developed in excess of the lower. The long teeth disappear, and the upper jaw grows into the toothless sword-like weapon which gives the fish its peculiar character.

CURIOUS HABITS OF FISHES.

No group of animals appears to have so many peculiarities in connection with the act of reproduction and the treatment of the eggs and young as fish, and Mr. W. Saville Kent has lately announced quite a new illustration of this fact in the London *Field*, as shown by observations made at the Westminster Aquarium upon the crested blenny of England. On one occasion his attention was attracted to certain bead-like bodies attached to the fins of one of the specimens lately received. These proved to be eggs, but it was not yet certain whether they were carried by the male or the female fish. Generally, where the eggs are protected by the parent, it is the male that assumes this duty. In the pipe-fish and sea-horse especially, the eggs, when laid by the female, are carried under the abdomen of the male until hatched.—19 *A*, *August* 19, 218.

MALE ROTIFER.

Mr. Henry Davis has succeeded in observing the male of the well-known *Conochilus volvox*. In the clear jelly in which these animals live two distinct kinds of eggs may be found—the female egg, transparent and nearly colorless; the other kind (ephippial of Huxley) somewhat larger, nearly opaque, and reticulated with dark lines within the shell; it is sometimes, though erroneously, called "winter-egg;" these are probably destined to preserve the species through the drought to which the ponds that the animals flourish in are constantly liable. A third kind, the male egg, is more rarely seen: it is transparent, showing the male neatly packed up, but even at this tender age restless and gymnastic beyond belief. The male, beyond his rarity, has little in him to admire. He is scarcely larger than the head of one of his sisters, and his constant endeavor while under the microscope is to prove himself without form and void; to simulate a preternaturally lively Amœba, and as soon as possible to wriggle himself first to decomposition, and then to death.—*Monthly Microscopical Journal, July*, 1876.

A WRESTLING-MATCH BETWEEN ANTS AND WASPS.

New facts regarding the habits and psychology of insects are of peculiar interest nowadays. Mr. Rothney, of Bengal, describes a wrestling-match between an *Ampulex*, the destroyer of the cockroach, and some ants. On visiting a tree he was surprised to see an unusual commotion going on between these two species of insects. "All over the trunk of the tree were couples engaged in a series of struggles or wrestling-matches—wasp *versus* ant; and so many individuals were occupied in this way, and their actions were so rapid, that for some time I could make little out of their proceedings." He therefore watched the movements of a single wasp, which was evidently keeping guard over a piece of smooth bark almost eighteen inches in diameter. An ant would come on the ground and meet the wasp halfway, when, after a series of manœuvres on the part of the wasp to get her favorite hold, she would jerk the ant a clear foot off the tree, and another and another ant would be treated in the same way. "During the time I watched the tree, I saw at least twenty ants thrown, but not one wasp 'tackled.' What was most curious was the fact that all this appeared to go on without the least ill-feeling between the contending parties, and a careful examination of the defeated ants showed them to be none the worse for their falls. I watched several; on their reaching the ground they seemed to be a little bewildered, but, soon recovering themselves, made for the tree again; two, in particular, in the most plucky manner, went straight for the spot from which they had been hurled, and tried another bout with the old opponent." This would seem to corroborate Huber's statement that he saw ants wrestling and playing with one another.—*Entomologists' Monthly Magazine, September*, 1876.

THE METAMORPHOSES OF BEETLES.

M. Perris, distinguished by his works on the metamorphoses of the insects of the pine, particularly of the beetles and flies, is publishing an elaborate work on the coleopterous larvæ found in the several species of chestnut, beech, and oak of France, particularly of the department of Landes. These three kinds of trees are closely allied, and so are the insects found upon them, many insects common to one species feeding indiscriminately upon the others; for example, almost all the beetles which live on the chestnut also prey on the oak. An important practical question is answered by Perris, whether the boring grubs of beetles attack healthy or sickly trees. Under the influence of the authority of Ratzeburg, and of facts imperfectly observed and appreciated by him, the forestry schools, and indeed the entomologists, both of Germany and France, had admitted that wood-boring insects attacked only healthy trees. But Perris insists that such insects, which make their attacks in great numbers as if acting by concert, and which consequently are very dangerous, usually only infest sickly and enfeebled trees. "This rule—for it is one—applies without exception, as I know, to insects whose larvæ pass their whole life or a part of it under the bark, namely, to those which are the more numerous and the more dangerous. The circulation of the sap in the inner layers of the bark of healthy trees, naturally very active, become still more excited by the presence of the larvæ, and thus they become smothered, as I have seen from examples thus killed." Certain beetles and other insects are an exception to this rule, such as *Compsidea*, etc., and there are species of this genus in America which destroy elm and other shade-trees while in health.—*Annales de la Soc. Linnéenne de Lyon*, 1876.

THE EYE OF FLIES.

Signor G. V. Ciaccio has published among the memoirs of the Academy of Sciences of Bologna an account of the anatomy of the eye of Diptera, describing the optic ganglion and optic nerve, the retina of which he finds composed of five coats, though still much more simple than in vertebrates. He then describes the pigment, the external envelope of the eye, and finally the tracheæ distributed to it.—*Journal de Zoologie*.

THE SEVENTEEN-YEAR CICADA.

Professor C. V. Riley has shown that there are thirteen as well as seventeen year races of this Cicada, and has predicted that "in the year 1876, and at intervals of seventeen years thereafter, they will in all probability appear from Raleigh, N. C., to near Petersburg, Virginia; in Rowan, Davie, Cabarras, and Iredell counties in North Carolina; in the valley of Virginia, as far as the Blue Ridge on the east, the Potomac River on the north, the Tennessee and North Carolina lines on the south, and for several counties west; in the south part of St. Mary's County, Maryland, dividing the county about midway east and west; in Illinois about Alton; and in Sullivan and Knox counties, Indiana." Specimens since received from Lexington, Virginia, were proof of the correctness of the prediction in regard to Virginia. While this insect requires thirteen or seventeen years, according to the race, for its underground development, the actual development has never been watched from the egg to the mature insect. In 1868 he had collected together in a particular spot near St. Louis a large number of the hatching eggs of a thirteen-year brood which will appear there again in 1881, and he had been able to obtain and note the development of the larvæ every year since. They are now (1876) about two thirds grown.—*American Naturalist, October.*

HOW COCKROACHES AND EARWIGS FOLD THEIR WINGS.

Several years ago Dr. Saussure, of Geneva, published some interesting observations on the structure of the wings of cockroaches. He treated particularly of the folding of the wings in those forms where the wing is very ample, and some contrivance necessary to insure its complete protection by the small wing-covers. The necessity of some peculiar arrangement in the winged genera of earwigs, where the extended wing is often ten times larger than the wing-covers, is even more evident, and to enable one to understand the subject Mr. S. H. Scudder gives a *résumé* of Saussure's paper, with additions of his own. In the earwig (*Forficula*) the wings are folded much as in the cockroach. The mode in which they are opened would be much more difficult to understand if it had not been observed by Charpentier, and described nearly forty years ago. The contraction of the extensor muscles attached to the hinder set of veins would undoubtedly cause the fan to expand when once the double folding, transverse and longitudinal, had been overcome; but it does not seem possible that they could cope with this difficulty. How, then, is it done? According to Charpentier, simply by means of the forceps with which the extremity of the abdomen is always provided in both sexes; the tip of the body is bent upward and the forceps used with great rapidity and ease, first on one side and then on the other, as a sort of fingers, to bring the wings into the position which would allow the action of the thoracic muscles upon the base of the principal veins. Still, adds Mr. Scudder, it is difficult to conceive how this operation can be performed by those species whose forceps are as long as their body.—*American Naturalist, September.*

THE LIFE OF THE COMMON HOUSE-FLY.

The life of the house-fly has thus been summed up by Dr. A. S. Packard, Jun. It lives one day in the egg state, from five days to a week as a maggot, from five to seven days in the pupa state—in all, from ten to fourteen days in the month of August—before the winged adult period. It is often asked how long-lived a fly is. Most of the flies which are born in August live for a month or six weeks, and die at the coming of frost, either of cold or from the attacks of fungoid plants. A few probably winter over and survive until midsummer, and thus maintain the existence of the species. —*American Naturalist, August,* 1876.

THE PHENOMENA OF DIGESTION IN THE COCKROACH.

In a late paper on this subject, Professor Felix Plateau concludes that the food after being swallowed accumulates in the crop, where it is acted upon by the salivary fluid, which is usually alkaline. There the starchy substances are transformed into glucose; this first product of digestion is here absorbed, and is not met with in the rest of the digestive canal. The valvular apparatus, which does not play the rôle of a triturating organ, allows small quantities of the matters in process of digestion to pass into the middle intestine of limited capacity. This median intestine, or stomach, as it is usually called, receives the sugar secreted by eight glandular cæca, the sugar being ordinarily alkaline, never acid, neutralizing the acidity as the contents of the crop gradually increase, transforming the albuminoids into bodies soluble and assimilable analogous to peptones, and emulsionizing the fatty portions. Finally in the terminal part of the intestine are reunited the residues of the work of digestion, and the secretions of the Malpighian tubes, which are purely urinary in their nature. These researches complete and confirm throughout the results of Plateau's former researches on the digestion of insects, published in 1874.—*Bulletin Academie Royale, Belgique*, XLI., 1876.

A NOISE-PRODUCING SPIDER.

Mr. Mason has exhibited to the Asiatic Society of Bengal specimens of a gigantic spider, of the genus *Mygale*, which possesses the power of making a strident noise. The sonorous organ of this animal is a comb formed by numerous elastic teeth of a chitinous nature, placed upon the lower face of the maxilla, and a scraper, composed of an irregular range of fine points on the external side of the chelicera. The apparatus is found in both sexes, as is the case with many of the coleoptera, instead of being restricted to the males, as among the orthoptera and homoptera.—14 *B*, IV., 528.

THE AFRICAN LOCUST IN GERMANY.

During the prevalent fear that the Colorado potato-bug will be introduced into Europe, an equally or even more dangerous pest has actually made its appearance in Germany in the shape of the African locust, *Acridium migratorium*, which has been found in the fields of Kerzendorf, on the Berlin and Anhalt Railway, where the insects have laid waste extensive tracts of land covered with good crops of grass and grain. Appreciating the necessity of prompt measures, however, the proprietors of the lands put a large force to work, and succeeded in destroying a great part of the insects before they could escape, digging numerous ditches and canals into which they could be swept and then covered with lime. Whether these insects laid their eggs before they were killed is of course impossible to know at present.—17 *A*, *August* 1, 1875, 117.

INEQUALITY OF THE SEXES IN A SAW-FLY.

Mr. Smith, at a late meeting of the Entomological Society of London, read some notes on *Nematus gallicola*, the gall-maker on the leaves of species of *Salix*, of which the male had apparently not hitherto been observed. From 500 or 600 galls collected in 1875 he had obtained multitudes of females and two males; a similar result in 1876 had resulted in one male. He was of opinion that by persevering from season to season, it was possible to obtain the male of this and of other allied species of which this sex is practically unknown, though these might occur at rare intervals, the female being capable of continuing the species without (of necessity) immediate male influence.—*Ent. Monthly Mag.*, *Sept.*, 1876.

AMERICAN FOSSIL INSECTS.

A fossil cockroach and an earwig (*Labidura*) from South Park, Colorado, is described by Mr. S. H. Scudder in the Sixth Bulletin of the United States Geological Survey of the Territories.

THE ARMY WORM OF THE NORTH.

A full account of this destructive caterpillar is given by Mr. Riley in his "Eighth Annual Report on the Injurious Insects of Missouri." It is very destructive to wheat and other cereals and to grass. Living unnoticed until they are more than half an inch in length, they begin to travel in armies and devastate our fields early in August. Mr. Riley has found that the females lay their eggs in strings of fifteen or twenty along the inner base of the terminal blades where they are yet doubled. The caterpillars hatch on the eighth or tenth day after deposition, and they moult five times before turning to chrysalids.

ADULT INSECTS WITH LARVAL HEADS.

A curious research has been made by Dr. H. Hagen on a butterfly (*Morpho*) from Brazil, which, though perfect in other respects, had the head of the caterpillar instead of the butterfly's head. It seems that a few other examples of such deformities are known, viz.: four butterflies and seven moths, three beetles and one fly. The presence of the head on the winged adult seems due to the weakness of the caterpillar or larva in casting the skin, that of the head becoming adherent after that of the rest of the body has been thrown off.—*Memoirs of the Mus. Comp. Zool.*, *May*, 1876.

HATCHING SILK-WORMS BY ELECTRICITY.

Silk-worms hatched by electricity are now being reared in Italy. The superintendent of the experimental silk-worm farm at Padua has found that the hatching of silk-worms may be accelerated ten or twelve days, and a yield of forty per cent. of caterpillars secured by exposing the eggs to a current of negative electricity from a Holtz machine for eight or ten minutes. It is suggested to apply the same method to hens' eggs, and to hastening the germination of seeds.—*Popular Science Monthly*, *November*, 1876.

PRECOCIOUS TRANSFORMATION OF A SILK-WORM INTO THE MOTH.

In 1792 Mr. Farini, of Forli, Italy, convinced himself of the fact that caterpillars may directly transform into moths without passing through a chrysalis state. He saw two boards filled with caterpillars of *Bombyx mori* transform into moths without having spun cocoons. In 1811 he received from a correspondent two such winged specimens. Dr. Hagen adds that the fact would be a rather interesting one if it were beyond doubt. As silk-worms are raised every year by millions, it would be supposed that the observations would have been oftener made and published.—*Memoirs of the Mus. Comp. Zool.*, *May*, 1876.

A PARASITIC MOTH.

An extraordinary case of parasitism has been noticed by Professor Westwood. The notes concerning this very unusual instance of parasitism by a moth were received by him (with specimens) twenty-six years ago from Mr. J. C. Bowring, of Hong Kong. It is a species of arctian moth, of the family of *Bombycidæ*, named *Epipycops anomala* by Bowring. The caterpillars were found attached to the dorsal surface of the *Fulgora candelaria*, the Chinese Lantern-fly, and as they grew had a cottony covering, which also occurred in the pupa state (a period very variable in duration). The whole circumstantial evidence tended to prove that it was upon the waxy secretion of the *Fulgora* that the larva fed, and that of this the cocoon of the pupa was formed.—*Entomologists' Monthly Magazine*, *September*, 1876.

REPRODUCTION OF THE ARMY-WORM.

An important announcement has lately been made by Professor Riley, the eminent entomologist of St. Louis, in regard to the eggs of the army-worm, *Leucania unipuncta*, in a paper lately read before the Academy of Science of that city. Dr. Riley states that at first view it seems singular that the eggs of an insect that appears in such countless myriads, from Maine to Georgia and from Virginia to Kansas, should have remained undiscovered either by farmers or entomologists. Stimulated by this rather discreditable fact, he made special efforts to solve the problem, which have been recently crowned with success by his having witnessed the mode of oviposition on the blue grass. The eggs, as he had supposed, were secreted, being either glued in rows of from five to twenty in the groove which is formed by the folding of the terminable grass blade, or in between the sheath and the stalk. Sometimes they were pushed into crevices in the ground, especially at the base of the grass stalk. The eggs are white, slightly iridescent, spherical, and only two hundredths of an inch in diameter. They are fastened to each other and to the leaf, and covered along the exposed portion by a white, glistening, viscid substance.

By the seventh day after deposition the brown head of the embryo shows distinctly through the shell. The larva hatches the eighth to the tenth day, being less than two millimeters in length, of a dull translucent white color, with a large brown-black head. On account of its extremely small size, and the color resembling the pale bases of the grass stalks near the ground, it is almost impossible to find them even where there are dozens to the square foot.—*Proc. Acad. Nat. Sc., St. Louis, May* 8, 1876, 1111.

STRUCTURE AND DEVELOPMENT OF MITES.

These animals, represented by the cheese and itch mite, are exceedingly numerous in species, and much attention has been lately paid to them, judging by the memoirs published in 1876 by French and German authors. Of the first importance is an elaborate work by A. L. Donnadieu, entitled "Recherches pour servir à l'histoire des Tétranyques," published in the *Annales de la Société Linnéenne de Lyon*, with twelve plates. The internal anatomy and metamorphosis are quite fully given, particularly the different modes of disposition of the air-tubes and their stigmata; also the varying form of the digestive canal, which in one instance (*Tetranychus plumistoma*) sends branches even to the extremities of the feet and the palpi. In Troschel's *Archiv* there are several papers of less importance on other families of mites by Dr. Kramer.

COLORING MATTER OF THE MUREX SHELL.

MM. de Negri state that, as the result of careful investigation into the coloring matter of certain mollusks, the *Murex trunculus* contains two coloring principles, one of which is perfectly equal to indigotine. This is obtained by exposing the coloring principle of the mollusk to the air until it assumes a violet tint; then washing it with crystalline acetic acid, which dissolves the tint. Water is then added to the acetic solution, and the whole shaken up with chloroform, which dissolves the purple. The chloroform solution leaves behind, after evaporation, the residue, which is violet. Washed in ether, this is deprived of the red principle contained in it, and the remainder is redissolved in alcohol. It is well known that the ancients preferred the secretion of the *Murex brandaris* to that of the *M. trunculus.* It is found that the secretions of these two species are by no means the same, and that their products from solution are different. In fact, the secretion of *M. brandaris* is photogenic; that is to say, it does not become colored by the deprivation of light, while that of *M. trunculus* becomes violet by contact with the air. In reference to the studies of the coloring matter found in the *A. viridis*, they remark that they have found chlorophyl in other mollusks, identical with the coloring matter of vegetine.—3 *B*, *December* 23, 678.

EIGHTH REPORT OF THE STATE ENTOMOLOGIST OF MISSOURI.

The eighth annual report on the noxious, beneficial, and other insects of Missouri, by Charles V. Riley, state entomologist, has just been received, and, like every thing from this writer, contains much matter of interest to agriculture and entomology. The noxious species to which special attention has been directed in this report are the Colorado potato-beetle, the canker-worm, the army-worm, the Rocky Mountain locust, and the grape-vine phylloxera. There is a special division upon innoxious insects, under which is mentioned the yucca-borer, which, according to Dr. Riley, is the only butterfly the larva of which has the boring habit. Under the head of the Colorado potato-beetle, we learn that it has become extremely abundant in the East, and that it lately swarmed to a remarkable extent on Coney Island; also, that a sprinkling of Paris green continues to be one of the most important means of preventing its ravages. From the experiments of Professors Kenzie and M'Murtrie it is shown that, contrary to the anticipations of some, there is no danger to be apprehended to the soil from the introduction of this poison. An extended article upon the Rocky Mountain locust contains the comforting assurance to the farmers of Missouri that no danger need be apprehended from it during the year 1876. In regard to the grape-vine phylloxera, which is now threatening the destruction of almost the entire system of the European vineyards, Professor Riley states that it has comparatively little effect on the American vines, and that the demand for these for exportation to Europe far exceeds the supply. Numerous well-executed wood-cuts add greatly to the interest and value of this important report.

METAMORPHOSIS OF THE CRUSTACEA.

From a study of the larvæ of thirty-eight genera of stalk-eyed crustacea, Mr. C. Spence-Bate has become convinced of the existence of a unity of character throughout the various forms and changes of crustacea; that variety in form is never inconsistent with homological truth; that parts suppressed or rendered abortive for want of use are never absolutely lost, and may be reproduced under conditions that may require them. The eyes of those crustacea, such as *Alpheus*, that inhabit dark places are reduced in power according to the condition of their habitat. But these organs are, in their larval state, as well developed, if not more so, as those of any species whose life is passed in the bright sunshine of the surface of the ocean. The blind *Deidamia*, brought from the depth of four miles below the surface of the Atlantic by the dredges of the *Challenger*, differs in no respect from *Polycheles*, taken by Heller in the comparatively shallow Adriatic

Sea. In the blind crawfish from the Mammoth Cave of America, and the sightless *Nephrops* of Formosa, the organs of vision are reduced to the smallest condition consistent with their retention; and in the Cirripedes the eyes are represented by their nervous apparatus only. No *Nauplius* form occurred. Mr. Bate believes that he has demonstrated that the three pairs of motile appendages in the Nauplius form of larva homologize with the eyes and two pairs of antennæ, and not with the antennæ and mandibles, as stated by Fritz Müller, Dohrn, and others.—*Annals and Magazine of Natural History, August.*

INFLUENCES OF EXTERNAL AGENCIES IN ARTEMIA.

Schmankiewitsch announces an interesting fact in regard to the variation of animal species, in studying the *Artemia salina* from the salt marshes of Odessa—a crustacean known from its power of resisting the influence of concentrated brine. At the beginning of his observations, owing to the rupture of a dike, the quantity of salt in the ponds was quite small, but after repairing the concentration proceeded very rapidly, and what began as a typical *Artemia salina* was gradually modified from generation to generation, so that in a few years the animal lost its caudal lobes, and then presented all the specific characters of a second species, the *Artemia mulhausenii.*

In an inverse experiment, or passing from a greater to a less degree of concentration, the *Artemia mulhausenii* was made to return to the form of *A. salina.* In further illustration of this subject, the author gives reasons for believing that the entire genus *Artemia* is only a degraded form of *Branchipus*, a fresh-water form, changed possibly by a transfer to a saline medium.—18 *A*, *January* 9, 423.

STRANGE ISOPOD PARASITES OF THE HERMIT CRAB.

M. Hesse has described two singular parasites belonging to the Isopod *Crustacea*, and which are related to the Idotæans, but are strangely modified by their parasitic habits. In one form (*Pleurocrypta*) the parasite lives under the carapace of its host, while in the other (*Athelgue*) the dorsal surface is applied interiorly on the abdomen of the crab, and its gills are exposed on this part of its body, while the entire animal is firmly held in place by its thoracic feet.—*Annales des Sciences Naturelles, July* 15, 1876.

HABITS AND ANATOMY OF A NEREID WORM.

The habits, but more particularly the anatomy, of *Nereis virens*, a common worm found between tide marks on the coast of New England, have been studied by Mr. F. M. Turnbull. This worm grows to the length of eighteen inches or more, and is commonly met with in digging clams. It is very active and voracious, feeding on other worms, but overlooking its own immediate relatives. It suddenly thrusts out its proboscis and seizes its prey with the two powerful jaws, then withdrawing the proboscis, the jaws closing at the same time. In this way it will tear large pieces from the body of its victim, being able at one bite to cut in two a worm of its own size. The tautog, scup, and other fishes dig them out of the sand and devour them eagerly. But at certain times, especially at night, they leave their burrows, and swim about like eels or snakes, in large numbers, and at such times fall an easy prey to many kinds of fishes. This habit seems to be connected with the season of reproduction. Turnbull's account of the anatomy of the nervous and circulatory system gives the best description yet published in this country of the structure of these worms, scarcely any thing, indeed, having been accomplished in this direction by American zootomists.—*Trans. Conn. Academy, August.*

DIGESTION IN MYRIAPODS.

In an elaborate memoir of ninety-four pages in quarto, accompanied by three well-filled plates, Professor Plateau describes the anatomy, gross and minute, of the Thousand-legs and Centipedes (*Myriapoda*) of Belgium, and the phenomena of digestion. Myriapods are either carnivorous or feed on vegetable matter. The Centipedes (*Chilopoda*) feed on living animals, such as flies and mosquitoes, as in the case of the common *Lithobius*, while *Cryptops* feed on earth-worms, other myriapods (*Geophilus*), spiders, and larvæ, while allied forms devour *Poduræ*. They hold them between their jaws, and kill them by the poison which pours into the double wound produced by the points of the jaws. The effects of the poison of the *Lithobius* on the domestic fly are almost as rapid as that of the spider. The vegetable-feeding forms (*Chilognathes*) are not poisonous. The process of digestion is carried on in the same general manner as in insects, the organs being constructed on the same plan. Plateau finds that, as in insects, the digestive liquid of Myriapods has no analogy with the gastric juice of vertebrates (its acidity in *Iulus* excepted). It does not curdle milk, emulsionate fat, nor in the carnivorous Myriapods clearly dissolve albuminoid matters. The material dissolved, salts, sugar (?), substances analogous to peptones, and emulsioned fats, pass by osmose directly through the thin walls of the stomach (there being no lacteals as in vertebrates), the surface of which is generally enormous in proportion to the size of the animal, and mixes with the blood in order to be assimilated. Plateau uses the term "salivary glands" for the glands in *Lithobius* and *Himantarium* which empty their contents into the mouth, but the fluid secreted by them is not like that of other insects and the vertebrate animals, which has the property of transforming starch into sugar, but in the two genera of Thousand-legs mentioned the fluid is colorless, neutral, or distinctly alkaline; nor is it poisonous.—*Mémoires Acad. Roy. Sc. Belgique*, 1876.

THE LARGE HUMAN FLUKE-WORM.

Dr. Cobbold thus puts in a pithy way the liability we undergo of becoming infested by parasitic worms: "Imitate the Cossacks, Burates, and Abyssinians in their fondness for raw meat, and you will be invaded by *Tæniæ;* or imitate the very similar habits of North Greenlanders in respect of fish, and you will probably enjoy the privilege of entertaining *Bothriocephali*. If you have a predilection for unfiltered waer, you are likely, sooner or later, to play the *rôle* of host to some highly irritating nematode guest; or, as frequently happens in Iceland and Australia, you will be particularly likely to contract the so-called *Echinococcus* disorder." He thinks that it remains to be proved that shell-fish are altogether unconcerned in the matter of human helminthism, yet he believes that danger from this source is limited to certain mollusca living in eastern waters. About thirty years ago Professor Busk discovered fourteen large flukes in the duodenum of a Lascar. This was described under the name of *Distoma crassum*, and it was not again met with until 1874, from two missionaries who had lived in China for about four years. In all probability it was obtained by the consumption either of fish or of shell-fish. An illustration of the rarity of parasitic worms is given by Dr. Cobbold. *Stephanurus dentatus*, a large nematode worm, was originally discovered by Natterer at Barra do Rio Negro, Brazil, in 1834. He found it infesting a Chinese variety of the common hog. It was shortly afterward described and figured by Diesing. Thirty-five years after (1869), Professor Verrill described what he very naturally supposed to be a new entozoon infesting the hogs of the United States, under the name *Sclerostoma pinguicola.* "Specimens of these worms, however, having been forwarded to me by Professor Fletcher, of Indianapolis, I at once saw that Verrill's *Sclerostomata* were the *Stephanuri* of Diesing and Natterer. Subsequently also I detected this self-same entozoon in a batch of parasites sent from Australia."—*Journal of the Linnæan Society, London.*

EMBRYOLOGY OF GASTROPODS.

Dr. N. Bobretzky, of Kiew, to whom we owe invaluable works on the developmental histories of *Astacus*, *Palæmon*, and *Oniscus*, has recently published in the *Archiv für Microscopischer Anatomie* a memoir on the embryonic development of Gastropoda. His observations relate almost exclusively to the marine forms of *Nassa*, *Natica*, and *Fusus*, and were made in Dr. Dohrn's zoological station at Naples. Six plates illustrate the work, which is remarkable for the fact that the studies of which it gives an account are the first in which the method of cutting sections has been applied to the examination of the very delicate and small eggs and embryos of Gastropod Molluscs. Dr. Bobretzky has also used and recommends a method which consists in hardening the embryo in dilute chromic acid, and then observing it under the microscope as an opaque object. Professor Ray Lankester gives an account, with excellent drawings, of the development of a pond snail, *Paludina vivipara.*—*Quar. Journal of Microscopical Science, October*, 1876.

REMARKABLE MODE OF DEVELOPMENT IN SALPA.

Dr. W. K. Brooks has discovered a most anomalous mode of development in the tunicate Salpa, which, it will be remembered, exists solitary and in chains. He concludes that the solitary Salpa is the female, and produces a chain of males by budding, and discharges a single egg into the body of each one of these before birth. These eggs are impregnated while the chain-salpæ are very small and sexually immature, and develop into females which give rise to males by budding. After the fœtus has been discharged from the body of the male, the latter attains its full size, becomes sexually mature, and discharges its spermatic fluid into the water to gain access to the eggs carried by other immature chains. It is worthy of notice that although Chamisso's announcement of the occurrence of alternation of generations among animals is thus seen to have been drawn from the study of animals which do not present an instance of it, this mistake has been of the greatest usefulness, since it has led to our knowledge of the numerous instances of true alternation which now form such a large and important chapter of zoological science.

The relation in which Salpa stands to the other tunicates shows also that no abrupt line can be drawn between alternation and ordinary sexual reproduction, but that they are different forms of the same process. On another occasion he attempts to show how all the strange peculiarities of Salpa receive a simple explanation upon the theory that Salpa is the descendant of an ordinary tunicate which has been modified by natural selection.—*Amer. Naturalist, November.*

STEPHANOCEROS ON SUBMERGED PLANTS.

Dr. Pierce has observed the rotifer known as the Stephanoceros growing on submerged plants near the Schuylkill River. It had not been previously noticed in that region. Dr. Pierce found that it fed on paramecia, which it seized by the extremities of its horns, and passed to its mouth by movements of the cilia which clothe them from apex to base. This Stephanoceros is inclosed for much of its length in an inflexible sheath; but at stated intervals the projected portion separates from its sheath, and swimming to another locality locates itself by the base. This Dr. Pierce observed to take place several times. He never saw any fœcal discharges from the animal, and suggests that the solid case is formed from them, and that the migration of the Stephanoceros is due to the final obstruction of this means of deposit.

GATHERING OF EUPLECTELLA.

Among the most beautiful objects in the way of natural curiosities is the now well-known *Euplectella*, or Venus's flower-basket, a cylindrical net-work resembling the finest spun glass woven together in open meshes of wonderful regularity. The *Challenger*, during her exploration, visited the single locality whence this object is obtained, off the island of Mactan, adjacent to Zebu Island, not very far from Manilla. The following account of the method of collecting it is given: "We had no sooner landed than we saw the sponges about every where, and we had no difficulty in getting a couple of fisherwomen on the following day to consent to guide us to the spot where they were found. The Indians came to us early in the morning, and we started with them in the steam-launch to the village, about six miles off, where they lived. There we took in two very curious and ingeniously contrived instruments, with which they bring the sponges up. Two long strips of bamboo meet at an angle of forty-five degrees, and are fixed in that position by an elaborate system of stays of bamboo, which are attached to a piece of wood which runs back from the angle between the two arms or wings of the machine. The piece of wood is weighted with stones, and a line is attached to it, so that the machine is pulled along on the bottom with the angle in advance and the two wings sloping backward, one on either side. The outer edge of each of the bamboo rods is armed with between thirty and forty large fish-hooks, with their barbs set forward toward the angle. The *regaderas*, as the Spaniards call them, are found at a depth of about one hundred fathoms. The Indian lets down the bamboo arrangement with a strong fine line of Manilla hemp, and pulls it slowly over the ground. Every now and then he feels a slight tug, and at the end of an hour or so he pulls it in, with usually from five to ten *regaderas* entangled in the hooks. *Euplectella* has a very different appearance, under these circumstances, from the cones of glassy net-work in the British Museum. Its silver beard is clogged with the dark gray mud in which it lives, buried to about one third of its height, and the net-work of the remainder of the tube is covered with a pall of yellowish fleshy matter, which gives it a heavier look and greatly diminishes its beauty. The layer of flesh is not so thick, however, as we expected, and only slightly masks the form of even the detailed sculpture of the sponge. It is not nearly so thick and spongy as it is in another species of the same genus which we dredged off the coast of Portugal."—12 *A*.

FRUSTULIA SAXONICA.

Dr. Woodward, U. S. A., has published an article upon the markings of *Frustulia saxonica*, illustrated by copies from photographs, and correcting some misstatements and misapprehensions in a previous communication by Mr. Hickie. It will be read with interest by all those engaged in testing objectives by means of the *Diatomaceæ.—Monthly Microscopical Journal, December*, 1875.

AULACODISCUS OREGONUS.

Dr. Christopher Johnson gives a very excellent representation of *Aulacodiscus oregonus* with two centres, and he inclines to Vrolick's opinion that this and other similar monstrosities are an evidence of the action of an excessive developmental potency. It is very well known that the sporangial frustule is sometimes, in cases of conjugation of the Diatomàceæ, the result of a differentiation of the endochrome, or internal contents of a single parent frustule; and in the gemmiparous increase the division always occurs, primarily, in the central nucleus; in either case it would not be difficult to account for an occasional monstrosity.—*American Journal of Microscopy, June*, 1876.

EOZOON CANADENSE.

Mr. W. S. Dallas has translated Otto Hahn's "Micro-geological Investigation of *Eozoon Canadense.*" In this paper Hahn comes to the definite conclusion that the *Eozoon* is a myth founded on a mistaken conclusion as to the micro-geological character of certain serpentines.—*April*, 1876.

FUSISPORUM SOLARIA.

In reference to this fungus, which commonly appears on diseased potatoes in company with *Peronospora infestans*, Mr. W. G. Smith states that the resting spores are about $\frac{1}{3500}$ of an inch in diameter, and are almost always accompanying the oospores of *Peronospora.*—*Gardener's Chronicle*, 1876.

DIATOMS IN THE CUTICLE OF WHEAT STRAW.

Articles detailing observations of Professor P. B. Wilson, of Baltimore, have appeared in several scientific journals (as the *American Journal of Science* for May, 1876), in which it is stated that diatomaceæ, in their entire state, are absorbed by the roots of plants, and make part of the silicious cuticle of wheat straw!

This assertion has, however, been promptly met by several eminent microscopists, who show that the diatoms in the Richmond earth used in Professor Wilson's experiment are all marine, while those figured and described by him as found in wheat straw are of fresh-water forms, and probably adhered to the straw when this was pressed to the earth of the field.

CLEANING FORAMINIFERA.

Mr. C. J. Muller recommends, for the purpose of cleaning foraminifera of the chalk, a mixture with four or five times its bulk of well-washed silver sand; with this, in a proper vessel and sufficiency of water, the chalk-powder is to be shaken, say for ten minutes, and after a few minutes' rest the turbid water poured off. The operation can be repeated until the water is clear. The sand acts as a gentle rasp, removing most of the hard granular particles; and the foraminifera are finally separated by gravity from the sand.—*Monthly Microscopical Journal, May*, 1876.

BATHYBIUS.

Professor Wyville Thompson, in a letter to Mr. Huxley, says that the best efforts of the staff of the *Challenger* have failed to discover *Bathybius* in a fresh condition; and Professor Huxley states that it is seriously suspected that the thing to which he gave this name is little more than sulphate of lime precipitated in a flocculent state from the sea-water by the strong alcohol. It is much more likely that what Professor Huxley observed was the gelatinous secretion of *Diatomaceæ*, which is produced in immense abundance in the ocean depths, and which behaves, under chemical reagents, very much like the so-called *Bathybius*. The letter will be found in *Nature*, *August* 19, 1875.

PROFESSOR T. RUPERT JONES ON THE FORAMINIFERA.

Professor T. Rupert Jones has published a paper on the variability of form in the foraminifera, especially as illustrated in the Cristellarians. The systematic grouping at present in greatest favor is based primarily on the texture of the shell, *porcellanous*, *hyaline*, or *sandy*; and, secondarily, on the arrangements of the segments of sarcode and the form of the shell chambers; and the author considers this the most natural method of grouping these extremely variable forms. While it is undoubtedly true, as Professor Williamson suggested as long ago as 1818, "that the hard shells of the foraminifera do not constitute a sufficiently constant and important element in their organization to justify our trusting to them as guides in the discrimination of species" (here referring to form rather than texture), we doubt very much whether the grouping based on texture can be any better relied upon. In the paper to which we have alluded, Professor Jones, who is, indeed, the highest authority, shows the gradual passage of these groups into each other; and he states that there are evidently several points where the differentiation of the great foraminiferal groups is by no means absolute, and that there are some general features of resemblance between all the three great groups in the style of growth and arrangement of the segments, and occasionally still more binding links. Certainly any system of classification that will do away with the unlimited multiplication of quasi-specific names, linked together by pseudo-generic titles, which can only weary the catalogue-maker and throw obstacles in the way of the systematist, should be accepted with thankfulness; but there is yet very much improvement to be made upon the system proposed by Messrs. Jones, Parker, and Brady, and we doubt, after all, whether form, with all proper allowance for possible variations from a normal type, is not at present as safe a basis for classification as shell structure. Thus the two otherwise undistinguishable genera, *Cornuspira* and *Trochammina* (as represented by *T. incerta*), are separated by the latter method, yet we are quite certain, from specimens obtained from soundings in the Bay of Campeche by the United States steamship *Fortune*, that they pass insensibly into each other; certainly they are nowise to be distinguished in form.—*Monthly Microscop. Jour.*, *Feb.*, 1876.

RECLAMATION BY DR. CARPENTER.

In consequence of the publication by Dr. Bessels, in the *Jenaische Zeitschrift* (vol. ix.), of a description of the animal and test of *Astrorhiza* as a new genus, Dr. Carpenter publishes an extract from a paper "On the Rhizopodal Fauna of the Deep Sea," presented to the Royal Society June 17, 1869, in which he describes this genus, which was first constituted by Dr. Sandahl in 1847, and has subsequently been considered as new by Bessels under the name *Haeckelina.* — *Quarterly Journal of Microscopical Science*, *May*, 1876.

PROFESSOR HUXLEY ON DEEP-SEA SOUNDINGS.

In a speech at the dinner lately given to the *Challenger's* staff, Mr. Huxley stated that the large areas of the sea-bottom covered with a kind of chalk, shells of minute creatures, have been proved beyond question remains of organisms which live at the surface, and not at the bottom—in fact, all living within one hundred fathoms of the surface. This conclusion is somewhat too sweeping. There is not the least doubt of the existence of living foraminiferæ at much greater depths; though indeed there may be myriads of free swimming forms, whose "cast-off clothes," as Mr. Huxley terms them, may aid in making the deposit. At vast depths —from 3000 to 4000 fathoms—the red clay is full of polycystinal minute sponges, and organisms with silicious skeletons. And even from some of these depths, where the abundance of carbonic acid in solution dissolves the carbonate of lime, some foraminiferal forms, with sandy tests, are living. The origin of this red clay—rich in iron and with nodules of manganese—is difficult to be explained. So marked is the character, that one after a little practice can almost judge of the depth by the color of the sounding. Many of the soundings of the *Tuscarora*, and some of them from very great depths, consisted entirely of diatom ooze, and the same was observed in the soundings of the *Challenger.* In the speech alluded to, Mr. Huxley suggests that the red clay may be decomposed pumice-stone, vomited out by volcanoes, or possibly may have something to do with that meteoric dust which is being continually rained upon us from the spaces of the universe.—12 *A*, *July* 13, 1876.

CEPHALOSIPHON AND A NEW INFUSORIAN.

Dr. C. T. Hudson concludes that the *Cephalosiphon* is a genuine Melicertan, forming its tube from early youth, and is not a temporarily incased *Philodine*, as had been supposed from having only one antenna. The new infusorian is named *Archimedea remex*, so called from its frequently assumed corkscrew shape, and from its rows of cilia used as banks of oars. The full-grown *Archimedea* is about one ninetieth of an inch in length, with a tube of one twenty-fifth of an inch, more or less, in length. It was found attached to *Anacharis alsinastrum*. The tubes are exceedingly slender, and readily deserted upon the least disturbance. They are, of course, far too long for its inhabitant, which, as a rule, lives in the top of it, though occasionally it backs down nearly to the bottom.—*Monthly Microscopical Journal*, *October*, 1875.

THE FRESH-WATER RHIZOPODS.

A large number of contributions to our knowledge of "Fresh-water Rhizopoda" have recently appeared in the *Archiv für Mikroscopische Anatomie*, and we condense the following from a very complete *résumé* by Mr. William Archer, who has long been known as an indefatigable student of these lively organisms. As for the name *Rhizopoda*, taken from the resemblance of the pseudopodia to the roots of a tree, it is manifestly inapplicable to the broad-lobed processes of a *Difflugia* or *Arcella*, and quite so to the flow and current of the body of an *Amœba*, or the rotating motion of a *Hyalodiscus*. Hertwig and Lisser have proposed the name *Sarcodina* (Sarcode organisms), with a division into two groups, *Monothalamia* and *Heliozoa*, and Mr. Archer's *résumé*, so far as published, relates principally to the latter.

The *Rhizopods* in question have been termed "Fresh-water *Radiolaria*." Haeckel calls them *Heliozoa*, considering them as unicellular organisms, all the true (marine) *Radiolaria* being multicellular, and, again, as not possessing a "central capsule," or structure homologous thereto; the rounded bodies seen in their sarcode, and sometimes regarded as a central capsule, are not to be interpreted as such; nor do they possess structures homologous to the "yellow cells of the *Radiolaria.*" This is also the view of Drs. Hertwig and Lisser, in their memoir in Schulte's *Archives*, 1874, *Supp.*, and in the main of Mr. Archer. Still, as we know nothing, or at least very little, of the developmental history of the two classes, it is possible that an affinity between *Radiolaria* and *Heliozoa* may be demonstrable—demonstrated at present it is not. The *Heliozoa*, then, are an independent class of unicellular (though sometimes, rarely, multonucleated) organisms. Their fundamental form a sphere, a very few fixed by a stipes. The protoplasm, of which alone the soft part of the body is wholly composed, is differentiated into an endosarc and ectosarc, more or less pronounced. In the endosarc constantly lie the nuclei; if the nucleus (as mostly) is simple, it is more or less excentric; if there be numerous nuclei, they are irregularly scattered. The ectosarc is characterized by the possession of contractile vacuoles (not yet demonstrable in all species). The pseudopodia, serving both for the capture of nutriment and for locomotion, are thin and filiform, originating all around the superficies of the globular body; sometimes homogeneous, and sometimes granules pass along them slowly up and down. In many of the *Heliozoa* is an extremely delicate axis, passing down the pseudopodium to the endosarc as a strengthening apparatus, but not at all homologous with the spines of the *Acanthometrida*, as Greef has suggested. In the paper we have alluded to, Mr. Archer considers the two genera of the *Heliozoa Askelata*, *Actinophrys* and *Actinosphænum.* The resemblance between these is considerable, but in the former the nucleus is always single, in the latter there are numerous nuclei; in the latter the two regions, both alveolar, are distinctly marked, in the former the endosarc is homogeneous, passing by degrees into the vacuolar ectosarc.—*Quart. Jour. of Mic. Science, July*, 1876.

H. BOTANY AND HORTICULTURE.

TREE GROWTH AND THE PRESSURE OF THE BARK.

The influence of the pressure of the bark upon the structure of the annual layers of woody fibre has formed the subject of an excellent memoir by De Vries, who states that while the classic work of Nordbinger (*Der Holzring*, etc., 1870) gives a complete *résumé* of our knowledge with respect to the connection between the thickness of the annual layers and the pressure of the bark, yet, on the other hand, the phenomena connected with longitudinal incisions still remain to be considered; and he has made a long series of experiments at the Botanical Gardens at Amsterdam, in which he first has diminished artificially the pressure of the bark by longitudinal incisions; and, second, has increased the pressure artificially by enveloping the tree with a tight cord. He has been able to demonstrate, first, that the radial diameter of the woody fibres depends upon the pressure exerted by the bark during their formation; the greater the pressure the smaller the radii of the fibre. Second, the number and the size of the vessels which exist in any woody shell depends upon the pressure exerted by the bark during the formation of the shell: to a greater pressure corresponds a smaller number and a smaller diameter of the vessels.—1 *E*, XI., 1.

THE ELM OF BOSTON COMMON.

In the Transactions of the Massachusetts Horticultural Society for the year 1876, some interesting remarks are published, made on the occasion of the prostration by a gale of the ancient elm on Boston Common, which event occurred on the 15th of February. Mr. Hovey stated that one of the only two living seedlings of the Charter Oak, and which was now forty years old, was at present standing on his own grounds at Cambridge. Mr. Wilder suggests that a young tree growing very near the roots of the great elm was probably either a seedling or a sucker, and should be planted on this centennial year as a successor to the old tree. Mr.

Cruickshank stated that during the week when the Charter Oak at Hartford was prostrated, a similar event occurred to an oak in Scotland under which the Scottish hero, Sir William Wallace, had once taken refuge. The Rev. Dr. Muzzy stated that the loss of old trees touches our patriotism, and that the Washington Elm at Cambridge was even more precious than the old elm on the Common. A number of remarks were made as to the importance of caring for old trees by cutting off long, dying limbs and encouraging the vigorous buds.—*Transactions Massachusetts Horticultural Society*, 1876, 84.

ON THE ACCLIMATIZATION OF PLANTS.

Mr. G. F. Waters, in making some general remarks on acclimatizing plants, states that in Waterville, Maine, he had developed a variety of the sweet-corn, which had been grown in a rich soil, having a southeast exposure, abundantly sheltered from the north winds. In successive years its time of ripening was, at first, the middle of October, next the middle of September, next the middle of July, and the fourth year the first of August. In five years it had, therefore, shortened the period of growth from four and a half months to less than two and a quarter months, and it had frequently been gathered for the table in sixty days from planting, while the ears had shrunk from sixteen to eight rows of kernels.

In some experiments on potatoes, the freezing of the tubers before they were dug, according to his experience, seemed to shorten the period required for the maturity of the next generation. He therefore formulates a theory as follows: If to the sun's influence there be added that of the autumn's frosts, checking maturation, and holding the food elements of the embryo where they are best fitted to be taken up in the spring, then we shall have seeds which will germinate still earlier, and as their plants will be longer under the accelerating influence of the increasing heat and light of the rays of the sun, they will show better development than their progenitors. From the discussion ensuing on the reading of Mr. Waters' paper, we gather that the general experience of the members of the society was not wholly favorable to Mr. Waters' theory; Mr. Hovey and Mr. Wilder had both of them but little faith in our ability to acclimate plants indigenous to a very different climate.—*Transactions Massachusetts Horticultural Society*, 1876, 70.

AN AGED OAK.

Mr. Amyot gives a very interesting account of the Winfarthing Oak. He states that at the time of the Norman Conquest a forest occupied the spot now known as Winfarthing; and in the reign of Henry III. a large park, well stocked with deer, covered the spot. The old oak is said to have been called "an old oak" in the time of William the Conqueror. Nor does this seem incredible, if we compare the measurements still extant with regard to it. The tree was first measured by Mr. Marsham in 1744, when its circumference was thirty-eight feet and seven inches. Its present circumference being forty feet, shows it to have increased seventeen inches in one hundred and thirty years. In 1820 the circumference of the tree at the middle part of its trunk is stated to have been forty feet. The best estimates that can be made of its age are based upon the average growth of oak-trees in that neighborhood, and show that it can not be less than fifteen hundred years old.—*Trans. Norfolk and Norwich Nat. Soc.*, II., 12.

WAXY MATTER ON BEECH BARK.

A green felty mass, formed on the bark of beech-trees, doubtless through the agency of some insect, was investigated by Flückinger and A. Köpp. It had a greasy feel, and under the microscope exhibited thin cylindrical, bent, and twisted fibres, which readily broke up into smaller pieces. A small quantity of other undeterminable substances accompanying it gave no clew to its origin. Water had but little effect upon it, and the extract was tasteless, and without reaction on litmus. The wax extracted from the crude material with boiling bisulphide of carbon, and purified by repeated crystallizations out of its solution in the bisulphide, formed white scales, which fused at 178° to 180°. Neither its analysis nor its reactions indicated identity with Chinese wax, (Pe-la)-cerotyl-cerotate, but its composition seemed to be that of cerotic acid, obtainable from Chinese wax, although the acid reaction of the solution of cerotic acid was wanting.—18 *C*, *September* 1, 1875, 548.

THE SIZE OF FAMOUS OAKS.

The following table, compiled from data given by Amyot, will be of interest to some. It purports to give the approximate, or, if possible, the exact age, and the dimensions of some of the famous and larger oak-trees in England:

The Winfarthing Oak; circumference, 40 feet; age, 1500 years.

The smaller Winfarthing Oak; circumference, 30 feet.

The St. Edmund's Oak, at Hoxne, to which King Edmund was bound by the Danes in 870, and pierced by their arrows; circumference, 18 feet.

The twelve oaks at Brome Hall, near Diss; circumference varying from 11 feet down to 7¼ feet, the average being 9 feet and 2 inches. They are all uniformly of the same age, 125 years.

Cowper's Oak; circumference, 47 feet; age, over 1500 years.

Cowthorpe Oak; circumference, 48 feet; age, 1600 years.

Leddin Oak; circumference, 30½ feet; age unknown. "Too old for naval timber" in Cromwell's time.

King's Oak at Windsor; circumference, 26 feet; age about 1000 years. "Favorite tree with William the Conqueror."

Flitton Oak; circumference, 33 feet; age, 1000 years.

Swilear Lawn Oak; circumference in 1830 was 19 feet; at present 21 feet 4 inches. "Known to have been a large tree 600 years ago." Age, 1000 years or more.

Bentley Oak; circumference in 1759, 34 feet.—*Trans. Norfolk and Norwich Nat. Soc.*, II., 11.

OAKS OF THE UNITED STATES.

According to Dr. George Engelmann (*vide* Transactions of Academy of Science, St. Louis, vol. iii., No. 3), the oaks arrange themselves into two great groups, the White oaks and the Black oaks.

"The White oaks are characterized by paler, often scaly, bark, tougher and denser wood, and sessile or subsessile stigmas, and bear the abortive ovules at the base, or rarely on the side of the perfect seed. Besides this, the leaves and their lobes or teeth are obtuse, never bristle-pointed, though sometimes spinous-tipped; their stamens are more numerous, the scales of the cup more or less knobby at base, the inner surface of the nut glabrous or (rarely) pubescent; the fruit generally matures in the first year.

"The Black oaks have dark, furrowed bark, brittle and porous wood, styles long, and spreading or recurved, abortive ovules always near the tip of the perfect seed. The leaves and their lobes are bristle-pointed, at least in youth; lobes and teeth acute; teeth sometimes spinous. Their stamens are usually less numerous, the scales of their cup membranaceous, the inner surface of their nut always tomentose; the fruit generally matures in the second year."

HETEROMORPHISM IN EPIGÆA.

Fruit is seldom met with in *Epigæa repens*, or common Mayflower. In the *American Journal of Science* Professor Asa Gray calls attention to the heteromorphic states of the flowers as follows:

"There are four kinds of flowers: the *first*, with long style and perfect stigma; the *second*, with perfect stigma likewise, but shorter style. Both have more or less abortive anthers lower than the stigmas. These two forms amounted together to less than twenty per cent. of a large number of specimens from one locality in Maine. In the *third* form, with longer style than No. 1, but imperfect stigma, the anthers abound with pollen, and are dehiscent at or a little before the opening of the corolla. The *fourth* has a shorter style, with the imperfect stigma as low as the base of the five longer anthers, otherwise as in No. 3. The flowers of *Epigæa* may therefore be classified into two kinds, each with two modifications: the two main kinds characterized by the nature and perfection of the stigma, along with more or less abortion of the stamens; their modifications by the length of the style. The first is leading to diœcism, the second points to dimorphism, a singular fact among *Ericaceæ*, which usually secure intercrossing by dichogamy, *i. e.*, by developing the anthers before or after the stigma."

GROUPING OF ZOOSPORES IN WATER.

When zoospores are swimming about in water, they frequently collect in masses of different shapes, but generally of some symmetrical form. This was supposed to be owing to the action of the light; but Sachs shows that it has nothing to do with the influence of light, but is dependent on currents in the water caused by differences of temperature in different parts of the fluid. He was able to produce similar figures by making an emulsion of oil, colored red with henna, with a mixture of alcohol and water. Sachs divides the figures formed into two classes, the polarized and the concentric. The former are formed when the opposite sides of the vessel containing the emulsion are unequally heated; the latter when the temperature is uniform. The fact that microzoospores appear to collect on the side of the vessel containing them which is toward the light, and the macrozoospores toward the dark side, is accounted for by Sachs by the fact that the macrozoospores, being heavier than the microzoospores, sink to the bottom, and consequently, inasmuch as the current on the surface of a fluid and that on the bottom are in opposite directions, they would be carried in the opposite direction from the microzoospores, which are near the surface.

AN INTOXICATING GRASS.

"Besides the 'Dronk' grass, *i. e.*, Drunk Grass, of the Dutch colonists in South Africa, it now appears that there is in Mongolia another plant with a corresponding native name and similar properties. It proves to be a new species of *Stipa*, brought from the Alachan Mountains by a Roman Catholic missionary, whose horses were disabled by its inebriating properties. The wandering Mongols of the region are familiar with this grass, and use vinegar as an antidote."—*American Journal of Science.*

SELF-BURYING SEEDS.

The essential points of structure common to all self-burying seeds are: (1) A sharp point more or less covered with reflexed hairs; (2) a strong woody awn, bent sharply at one point, so as to be divided into a lower vertical and an upper more or less horizontal part, the vertical part being strongly twisted on its own axis (or forming a helix, as in the Geraniaceæ). The hygroscopic phenomena exhibited by all the seeds are: (1) On being wetted the vertical part of the awn untwists, and causes the straight horizontal part to revolve and describe a circle in a horizontal plane; the angle between the vertical and horizontal parts also gradually disappears, and the awn becomes straight; (2) as the awn becomes dry again, the movements just described are reversed, the angular bend and the torsion of the lower part of the awn appearing. What special advantage it may be to a plant that its seeds should be buried is uncertain; in the case of Stipa, at least, it seems to have no connection with germination; it is conjectured that it may serve as a protection against graminivorous birds, etc.—*Naturalist, June,* 1876.

DOES THE AGE OF A TREE INFLUENCE THE TIME OF LEAFING?

M. Alph. de Candolle caused observations to be made in the botanical gardens of Paris and Pisa to settle this point. Unfortunately, however, the results were negative. M. De Candolle refers to one case in which the date of coming into leaf of a horse-chestnut tree has been carefully recorded for sixty-eight years, and another for fifty-seven years; both at Geneva. Of course any differences due to age would be small in comparison with those due to climate, yet they might be expected to be sensible in the long series of years if age really made any difference. But the figures do not bring to view any tendency to either earlier or later leafing with the advance of years.—*Archives des Sciences de la Bibl. Universelle.*

FLOATING SEEDS.

There is a considerable number of seeds with a specific gravity less than that of water, some as low as 0.75. Van Tieghem finds that this is due to different causes. More commonly the seed owes its lightness to its coats, either by a separation between the two in drying, or between the inner and the kernel, leaving an air-space, or by a loose cellular structure of the coat. Sometimes, as in castor-oil seeds, the integument is heavier than water, but the kernel is so much lighter as to float the seed. This comes from a separation of the two cotyledons during the natural desiccation, leaving a considerable cavity filled with air.—*American Journal of Science.*

RAPID GERMINATION.

Most gardeners have either heard or read of, if not seen, the singular rose of Jericho, *Anastatica hierochuntina.* The plant belongs to the Cruciferæ, and is a dwarf radiately branched annual, inhabiting the sandy wastes of North Africa and Syria. We may repeat here that when the individual plant has fulfilled its mission—that is to say, produced flowers—and when the seed is in course of ripening, the leaves decay and fall off, and the branches curve inward, forming a ball of the entire plant. After this it soon becomes detached from the soil, and is blown hither and thither with the moving sands.

During this time the seed-vessels remain closed, but the first rain causes the branches to unfold and the seed-pods to open. Now it is obvious that the most favorable condition for the continued reproduction of an annual plant in the shifting sands of the desert must be quick germination and growth and a kind of locomotion. The strange prickly, almost or quite leafless shrubs and undershrubs characteristic of the desert flora retain their vitality for years, alternately buried beneath the sand and exposed to the influences of the sun and air; but an annual plant would probably soon become extinct under the same conditions. According to a writer in the *Gartenflora*, seeds of the *Anastatica hierochuntina*, sowed about five o'clock in the afternoon, had germinated by one o'clock the following day, and their rootlets had already pierced the soil. These seeds were taken from a plant purchased at the Vienna Exhibition, and twelve out of fifteen germinated in the time mentioned in a pot covered over with a saucer, and standing in an ordinary living-room. This, like the germination of the seeds of the mangroves on the trees, seems to be a special provision for the perpetuation of the species.—18 *A*, *September* 15, 1876, 11.

A NEW NOXIOUS WEED.

Of late years, among other noxious weeds at the South, one has appeared in great abundance, the hooked sides of which attach themselves very rapidly to the legs of cattle, and constitute a frightful nuisance, which, indeed, is spreading, and threatening to make its way over the whole United States before long. According to the Bulletin of the Torrey Botanical Club, in 1851 a woolen-factory near Augusta, Georgia, received a quantity of wool imported from Buenos Ayres. This contained a great number of small burs, which were separated by the picking-machine, and the "trash" thus removed was thrown outside of the building. From these the species has been disseminated. It is known as the *Acanthospermum xanthoides.—Bull. Torrey Botan. Club, May,* 1876.

INVESTIGATIONS ON AMERICAN GOOSEBERRIES.

Professor Gray, in an article in the *American Naturalist* for May, in reference to the unsatisfactory condition of our knowledge in regard to the American wild gooseberry, invites botanists throughout the country to furnish information and specimens by which the difficulties may be cleared up. The species so far known to botanists are eleven in number, but the history of several of these is very indefinite.—*Bulletin Torrey Botan. Club, May,* 1876.

EXHIBITION BY THE AGRICULTURAL DEPARTMENT OF AMERICAN WOODS AT THE CENTENNIAL.

One of the most interesting features of the government exhibition at the Centennial is the collection of sections of forest trees displayed by the Agricultural Department, made under the direction of Dr. George Vasey, botanist of the department. This includes nearly 400 species and varieties of native North American trees, gathered directly for this occasion by twelve collectors in various parts of the Union. They embrace 50 species of sub-tropical trees of Southern Florida, including five that are new to our flora, and obtained by Dr. A. W. Chapman; 25 species from Texas, one of them believed to be new; 30 from Southern California and Arizona, embracing the tree yuccas and a recently known palm; 50 species from the Pacific slope of California; and 10 or 12 of the peculiar forms of Oregon. Among the 30 species from the Sierra Nevada Mountains are large sections of some of the noblest conifers of the world, such as the sugar-pine, the Douglas spruce, the silver-fir, and others.

The Rocky Mountains in Colorado and Utah furnish about 30 species; Illinois and the Western States, 50; Vermont, 20; and Virginia about 50, most of the latter being from the Mount Vernon estate, near Washington.

From the Southern States, exclusive of South Florida, there are about 90 species, one of them believed to be new. There are 30 species of oaks, 30 of pines, 16 of spruce, and 20 of other conifers. There is one extremely interesting group, consisting of the tree palmettos, palms, and yuccas of the United States, embracing the Sabal palmetto from Florida, one palm from California, two yuccas from Florida, and three from Texas, Arizona, and California.

The sections referred to are not mere hand specimens, such as are usually found in collections, but in many cases they are two or three feet long, and of the full trunk whenever this is not too large for exhibition.

LIVING TREES AT THE CENTENNIAL.

Among the more interesting exhibitions at the Centennial is a collection of living woody plants exhibited by Mr. Thomas Meehan, of Germantown. These plants were all grown for a certain time in boxes, with special reference to their transplantation, and were inserted in the ground with balls of earth around them, so that they are now growing very vigorously. As this collection is for sale after the close of the Exhibition, it offers an excellent opportunity to any establishment in the United States that wishes to secure a collection of American plants of extraordinary completeness.—*D. Ill. Gewerbezeitung*, XXIII., 1876.

CHANGES OF COLORATION IN FLOWERS BY ARTIFICIAL MEANS.

The French *Journal of Horticulture*, in an article upon the changes of coloration which certain natural flowers undergo, remarks that if violet flowers are exposed to the smoke from a burning cigar they change color and assume a tint of green, which is decided in proportion to the brilliancy of their original color. This is due to the ammonia in the smoke. Starting out with this fact, Professor Gobba has made a series of experiments for the purpose of determining the changes which ammonia produces in the colors of different flowers. For this purpose he merely makes use of a dish in which is poured a small quantity of common aqua ammonia. Over this he places a funnel, in the tube of which are inserted the flowers to be experimented upon. In this way he has shown that blue, violet, and purple flowers change to a beautiful green; deep red carmine flowers to black, white to yellow, etc. These changes are most striking where the flowers have several different tints, in which the red lines are turned green, the white yellow, etc. An interesting example is that of the fuchsias, with white and red flowers, which, in consequence of the ammonia vapor, become yellow, blue, and green. If, when these changes have taken place, the flowers are immersed in pure water, they preserve their new colors for several hours, after which they gradually resume their original tints. Another observation due to Mr. Gobba is that the flowers of the asters, which are naturally inodorous, acquire a very agreeable perfume under the influence of ammonia. The flowers of the violet asters also become red when they are moistened with a diluted solution of nitric acid. Again, these same flowers, if exposed in an open box to the vapor of hydrochloric acid, become after some hours of a beautiful carmine red, which they preserve after being dried in the dark, if kept in a dry, dark place.—1 *B*, *April* 4, 1876, 422.

PRESERVATION OF CUT FLOWERS AND BOUQUETS.

A German journal recommends for the preservation almost indefinitely of cut flowers, singly or in bouquets, to dip them in a solution of pure albumen, and, after allowing them to become perfectly dry, to repeat the operation several times, each time with fresh albumen.—10 *C*, *May* 1, 1876, 79.

VARIETIES OF INDIA RUBBER.

A recent writer enumerates the following varieties of India rubber as known in commerce: 1, Ceara rubber; 2, Para rubber; 3, Quisembo balls from Sierra Leone; 4, African knots in small irregular quadrangular pieces about an inch square; 5, Mozambique rubber; 6, African niggers in small round lumps about two inches in diameter; 7, Madagascar rubber; 8, Carthagena rubber; 9, Borneo rubber; 10, Rangoon rubber; 11, African rubber; and, 12, Guayaquil rubber from Ecuador.—*D. Ill. Gewerbezeitung*, XXIII., 1876.

A NEW DRYING OIL.

The *Elæococca Vernicia*, or *Tong-Yeou*, a tree growing in China and Cochin-China, produces abundantly a fruit consisting of a capsule filled with grains rich in oil. This oil is easily extracted by pressure, has a density of 0.9362, and possesses a variety of curious properties. According to Cloez, who has lately submitted it to thorough investigation, it dries more rapidly than any other known oil, a coating of it applied to glass or clean metallic surfaces becoming dry in a very few hours. An attempt will probably be made to acclimatize the plant in Algeria, with a view toward rendering it useful in the arts and introducing it into commerce. One of the most remarkable facts connected with the oil is its power of solidifying under the action of light and out of contact with the air. Heated in the air it also becomes solid, this change being, however, a chemical one due to oxidation. —6 *B*, *September* 13, 1875.

THE HEATH IN AMERICA.

It has been a generally received impression that North America, in distinction from Europe, is without any species of heath or heather, a few specimens of the *Calluna vulgaris* detected in Newfoundland having been considered as introduced rather than as indigenous. Great, therefore, was the gratification of sentimentalists at the discovery of this plant in Tewksbury, Massachusetts. Afterward the same plant was discovered in Nova Scotia and Cape Breton, and subsequently on Cape Elizabeth, near Portland. Dr. Gray now announces in the *American Naturalist* the discovery of a second station in Massachusetts, to the west of Andover, about five miles north of the Tewksbury station. A signal feature in this connection is the vicinity of a glacial moraine which traverses the district.—5 *D*, *August*, 1876, 490.

EFFECT OF SOLUTIONS ON A GROWING VINE.

Baudrimont has been continuing his experiments upon the influence upon the branches of a growing vine of immersion in water containing various substances in solution, and has obtained some rather remarkable results by various poisonous agencies, some appearing actually to increase the vigor of growth of the vine and prolong its existence, as in the case of chloride of potassium; while others cause the plant to wither, as in creosote and carbolic acid. Bromide and iodide of potassium seem to act in the same manner as chloride of potassium. Chloral hydrate exercises a very poisonous influence, destroying the branch vine in three days, the effect differing from that of carbolic acid. One of the most curious phenomena is that which is exhibited in the fall of the leaves. In some instances the petiole becomes detached at the point where it is inserted in the branch. This takes place in case of most substances, such as bichloride of mercury, and chloride, bromide, and iodide of potassium. In other cases it is the limb which separates from the extremity of the petiole. This occurs with ordinary water, and the nitrates of ammonia, potash, and soda. In one single instance both forms of separation have been observed, under the influence of the same substance. Sometimes, again, the branch dies while the leaves continue to adhere to it. This is the case after the use of hydrocyanic acid and the essence of turpentine. Chloride of potassium acts as an invigorating and preserving agent, quite exceptional in its character. A current of ammonia allows the branch to preserve its freshness for eight days, after which it withers.—1 *B*, *December* 20, 1874, 189.

PLANTS OF NEW GUINEA.

The *Gardener's Chronicle* states that letters received from Ternate mention the fact that Dr. Beccari has discovered on Mount Arfok, in New Guinea, quite a number of new species of plants of well-known genera, belonging to very different portions of the globe. Among these are *Araucaria*, species of *Vaccinium*, *Rhododendron*, *Podocarpus*, etc.

SECRETION OF DROSERA.

The alleged insectivorous habits of certain plants, such as *Drosera* and *Dionœa*, have attracted attention to the question of the composition of the viscid substance secreted by the glands on the leaves of species belonging to the former of these genera. The properties of this substance are evidently closely analogous to those of the pepsin which is the ferment secreted in the human stomach, and it is said even to give off the odor of pepsin on treating with sulphuric acid; but the quantity in which it has hitherto been obtained is too small to admit of accurate analysis. Professor Frankland, of London, obtained results which convinced him that the substance was an acid or mixture of acids belonging to the fatty or acetic series; and he thinks he obtained certain evidence of the presence of propionic and probably also of acetic and butyric acids. Mr. Lawson Tait, of Birmingham (England), on the other hand, believes he has proved the main ingredient to be lactic acid, while Professor Will, of Erlangen, finds formic acid to be certainly present (which Frankland failed to detect), as well as indications of propionic and butyric acids. Mr. A. W. Bennett, of London, has detected glands in the leaves of Drosera and Pinguicula, which seem to have hitherto escaped attention, and which he believes to be intimately connected with the processes of absorption and digestion.

FLORA OF GUADALUPE ISLAND, LOWER CALIFORNIA.

Mr. Sereno Watson publishes in the Proceedings of the American Academy of Arts and Sciences a report on the Guadalupe Islands of Lower California, lately explored very thoroughly by Dr. Edward Palmer. In this he shows that the flora is to be considered as part of that of California, as distinguished from that of Mexico, but that it has been derived to a considerable degree through human agency. Those of the most recent introduction might be expected to be Californian; the older might be from the nearer peninsula, or from other localities. It might be inferred, also, that it has not been derived from California by any existing process of conveyance and selection, but that it is rather indigenous to its present locality. Moreover, while it would indicate a connection at some period between the island and the mainland to the north, yet the number and character of the peculiar species favor the opinion that they are the remnant of a flora similar to that of California, which once extended in this direction considerably to the southward of what is now the limit of that flora upon the mainland. Finally, the presence of so many South American types suggests the conjecture that this and the similar element which characterizes the flora of California may be due to some other connection between these distant regions than any which now exists, and even that all the peculiarities of the western floras of both continents had a common origin in an ancient flora which prevailed over a wide now submerged area, and of whose character they are the partial exponents.

The study of the birds collected by Dr. Palmer suggested somewhat the same conclusions. These are in every respect closely allied to those of California, but sufficiently different to entitle them to be considered as well-marked geographical races, no single species of the land birds found being precisely identical with one of any other part of the continent. It should be remarked that the island is about 100 miles from the coast of Lower California, and 230 miles west of south from the town of San Diego. It is twenty-six miles long and about ten miles in width, and has a mountain ridge with one elevation of 3900 feet above the level of the sea.

VARIATIONS IN PLANTS WITH THE ALTITUDE AT WHICH THEY GROW.

According to Ebermeyer, the size of leaves of a given species of tree is considerably affected by its height above the sea-level; with equal strength of soil the leaves decreasing with the height. In the case of the red beech of Germany, the surface of the leaves on low lands is three to four times greater than on the mountains. As a general rule the quantity of humus in mountain forests is greater than in those lower down, owing to the slower decay of the leaves consequent upon a lower temperature. It is given as a remarkable fact by Ebermeyer that the entire amount of ashes of the strewn materials decreases with the height, and that the proportion of phosphoric acid, especially in the ashes, is much less in high positions than on lower ground. Hence it follows that the value of the dead leaves as manure decreases in general with the height, and that, consequently, the carrying away of material from the low lands for other purposes is much more disadvantageous than from the mountains as far as plant nutrition is concerned.—18 *A*, *February* 26, 1875, 601.

OCCURRENCE OF THE PALM-TREE, SCHEELIA REGIA.

Bruchmüller narrates that in his passage up the Magdalena River, New Granada, he noticed a tall palm—*Scheelia regia*—so entirely surrounded by a growth of a species of fig-tree—*Ficus dendroidea*—that the top only was visible. This species of palm, under the names of Palma roal and Palma dé vino, occurs frequently lower down the river, and the natives obtain from it a covering for their huts, and prepare a kind of wine similar to champagne from the sap and a most excellent salad from the heart, while other portions afford strong fibres.—1 *C*, II., 1875, 14.

THE TRUE JUTE PLANT.

There appears to be considerable confusion as to the plant from which the substance so extensively used in the arts under the name of jute is really derived. On investigation, however, it appears that the crude jute comes from two species of *Corchorus*, namely, *C. capularis* and *C. olitorius*, grown principally in Bengal. Plants popularly known as jute, however, growing in the Madras Presidency, are the *Hibiscus cannabinus* and *Crotalaria junca;* and their fibre is not the true jute, though hitherto considered such.—12 *A, February* 18, 1876, 314.

DEVELOPMENT OF FUNGI.

The following is condensed from an exceedingly interesting and well-illustrated paper, by Worthington G. Smith, F.L.S., on reproduction in the mushroom tribe. The author finds when a single specimen of *Coprinus radiatus* has been placed on a slide with a drop of water, under a covering glass, and this again under a propagating glass, that as the millions of fungous cells quickly disappear, so millions of infusoria just as quickly come into being; and he says, "It seems almost reasonable to believe that the fungous cells themselves become suddenly transformed, and reappear as simple infusoria." A dozen semi-decayed specimens of *C. radiatus*, swarming with minute infusoria, were boiled in a test-tube for five minutes, and then hermetically sealed at the highest point of ebullition. At the end of a month the tube was opened, and a drop of its liquid contents at once placed under the cover-glass of the microscope for examination. Spores, cells, monads, bacteria, and vibriones were all there, but the latter motionless and apparently dead. In fifteen minutes, however, they showed signs of life, and began to slightly move about; in thirty minutes the movements were decided in nearly every specimen seen, while in sixty minutes the infusoria darted about with almost the same energy as they did before they were boiled. As there are about 22,500,000 cells in one of these minute plants, requiring fourteen days for their production, it follows that the cells go on multiplying all the fortnight at the rate of 1114 to the minute. In about five hours 3,000,000 spores are produced.

They as a consequence appear upon the basidia or spore-bearing spicules at the rate of 100,000 every minute!—*Gardener's Chronicle, October* 16–23, 1875.

GLANDS OF CARNIVOROUS PLANTS.

Those plants which possess the peculiar power of absorbing and digesting nitrogenous substances presented to their leaves are principally insectivorous plants, belonging to the genera *Drosera*, *Pinguicula*, *Dionæa*, and *Utricularia.* In all these, minute glands exist imbedded in the surface of the leaf, reddish-purple in *Dionæa*, and giving a red tinge to the leaf. They are smaller than stomates.—*Monthly Microscopical Journal, January*, 1876.

THE POTATO DISEASE.

For more than thirty years our potato crops have been systematically destroyed by two virulent fungi, viz., *Peronospora infestans* and *Fusisporium Solani:* these two parasites almost invariably work in company with each other; they suddenly appear for a few weeks, destroy our crops, and vanish for ten or twelve months, then reappear and repeat the work of destruction. Mr. Worthington G. Smith has shown how these fungi hide and sleep through eleven months of the year. He has kept the resting spores of both parasites alive, artificially, in decayed potato leaves, under water, in moist air, and in expressed juice of horse-dung; it is fair to conclude that the resting spores hibernate naturally in the same manner. The seat of danger from both parasites is clearly in dung-heaps and decaying potato plants. In July last Mr. Smith obtained the oospores, or resting spores, by keeping potato leaves and tubers constantly moist, and preserved the material in which the resting spores were present in sealed bottles, containing more or less pure water, or expressed juice of horse-dung diluted with water, quite in the dark as to what the results might be. After waiting with considerable anxiety, and dividing the material to insure against loss, and keeping it constantly moist and in the dark, and under examination every day for over three months, during the latter stages of growth he detected the following changes: Many of the resting spores increased in size to twice their original dimensions during the first nine months, changing from almost smooth and transparent bladders, to brown, somewhat rough, and warted or echinulate spheres. Similar ones had been previously observed in the natural growth the previous summer, though no one then could account for their origin. At the end of nine months germination began, the resting spores became dense and dark, the oospore occupying the whole of the oogonium, instead of floating freely inside as in the immature spore; the contents of many of them were broken up into zoospores with two tails, which live in this form somewhere between twelve hours and a week, when they come to a rest and the tails disappear. Many of the zoospores perished, but others threw out threads of mycelium, which were destined at length to bear the conidiphores of the potato fungus. The oospores which did not produce zoospores protruded a thick, jointed thread, agreeing exactly with average *Peronospora infestans* threads. As any method of destroying the resting spores of these pests depends upon a knowledge of their life-history, this contribution of Mr. Smith will be welcomed as a move in the right direction. The paper itself, with four plates, was first published in the *Gardener's Chronicle*, 1876, p. 39–42, and since in *Grevillea* and the *Monthly Microscopical Journal*, *Sept.*, 1876.

DISEASES OF OLIVE AND ORANGE TREES.

Professor W. G. Farlow, of Harvard, has recently been investigating the disease of olive and orange trees, caused by fungous growths, and has arrived at the following results: The disease first attracts the eye by the presence of a black fungus, which however is not the cause of it, but rather the attack of some insect, which itself deposits a gummy substance on the leaves and bark, or so wounds the tree as to cause some sticky exudation, on which the fungus especially thrives. In seeking a remedy, we are to look farther back than the fungus itself—to the insect or whatever it may be which has made the luxurious growth of the fungus possible. It is the same on both olives and oranges, and has been described by Tulasne as *Fumago salicina*, found on willows, oaks, birches, hawthorn, quince, and pear, the stylospore-bearing portion being the *Capnodium citri* of Berkeley and Desmazières, and the pycnidal form the *Antennaria elæophila* of Montagne. Professor Farlow suggests as a remedy alkaline soaps, strong as the trees will bear.

I. AGRICULTURE AND RURAL ECONOMY.

USES OF PRODUCTS OF THE STONE-PINE TREE.

The stone-pine of Europe is applied to a great many uses, some of which may suggest a similar employment of the well-known piñon, or stone-pine of Colorado, New Mexico, and the central portions of the United States. The seeds are considered preferable to almonds, in consequence of their more delicate and aromatic taste, and they are said to be chiefly consumed on steamboats during long voyages, and for dessert at the principal hotels. In portions of Europe the investing pellicles are used for filling mattresses for hospitals, and they are said to make very wholesome beds. The unopened pine-cones are believed to be efficacious in preserving cloth garments and furs from moths.—17 *A*, *July*, 1875, 105.

COVERING THE SLOPES OF THE ALPS WITH FORESTS.

Among the objects exhibited at the recent Geographical Exposition in Paris is a series of maps illustrating the progress in reclothing the slopes in the Department of the Basses-Alps with a growth of wood, this relating especially to the basin of the torrent of Bourget, commenced in 1869. Considerable time was occupied by the preliminary surveys, but the process of replanting has already been begun with such effect as to insure the protection of the hamlet of Bourget, which had been threatened with destruction by being washed away. The influence exerted upon population and human existence by deforesting or the destruction of the woods is shown by the fact that in 1846 the population of one Department in the Alps of France amounted to 150,000 persons, while in 1872 only 137,000 could be enumerated, 13,000 having been forced to remove elsewhere in consequence of the decreasing quantity of fertile land.—1 *B*, 348.

THE PROPER TIME FOR CUTTING TREES.

An extensive inquiry has been made in Prussia into the effect upon the durability of woods of the season at which the trees are cut down. In general, the wood felled when the sap is not running has a decided pre-eminence as to its durability, strength, and density. The heat given out in burning wood felled in December and January is also, according to these experiments, greater than for woods cut in February and March.—7 *C*, XI., 123.

THE DESTRUCTION OF FORESTS.

The rapid and improvident destruction of our forests, and the prevailing indifference displayed on the subject of their conservation and cultivation, has become an almost stereotyped theme of warning and regret. It is demonstrable that the immediate consequences of this improvidence are an inconstancy and diminution of the rainfall, and a general deterioration of climate, to say nothing of a host of more remote and complex evils that follow inevitably in its train in course of time. These consequences have been abundantly realized in the desolation that has overwhelmed once fertile districts of Europe, and has stimulated the enactment and enforcement of wise laws which our lawgivers would do well to imitate. Councilor Wex, at the recent yearly meeting of the Geographical Society of Vienna, gave an able review of this most important subject as it affected the water supply of Central Europe. From the facts adduced in his paper, Herr Wex demonstrated a fall in the level, since fifty years, of 17 inches in the Elbe, 24.8 inches in the Rhine, 17 inches in the Oder, 26 inches in the Vistula, and in the Danube at Orsova as much as 55 inches. Accompanying this fall in level, which means so much of a decrease in the volume of these rivers, there was also shown to be a constantly increasing diminution of the discharge from springs. It would be instructive to have trustworthy data upon this subject from that portion of the United States east of the Rocky Mountains where the destruction of timber land has been for years going on on a scale of unparalleled magnitude.

CULTIVATION OF THE BAMBOO IN FRANCE.

A peculiar variety of bamboo has been sent to the Acclimatization Society of Paris, which it is believed will readily adapt itself to the climate of France, and may prove of very great value. It is said, indeed, that the French growth has already become an article of export to England, being very hardy, and able to sustain itself in both hot and cold countries. It grows rapidly, attains a height of thirty yards, and multiplies very fast.—17 *A*, *July* 1, 1875, 107.

CAOUTCHOUC FROM MILKWEED.

A report has gone the rounds of the technical press that the manufacture of rubber from the milkweed (*Asclepias*) has been undertaken by a company in Canada with a large capital. The milky juice of this family of plants is said to yield four per cent. of caoutchouc.

NEW LARGE JAPANESE RADISH.

A new variety of radish, the seeds of which were forwarded from Japan by Dr. Genou, has been introduced into the French market under the name of *Raphanus acantiformis*, and is pronounced an acquisition of value. In color it is milk-white, with a tinge of yellow, and it is firm, transparent, and juicy, and of delicate flavor, while the skin is thin and peels off easily. In Japan, where it is cultivated under the name of *Daicon*, it frequently attains a length of thirty-five inches, with a corresponding thickness; and it is used in a great variety of forms as food, and is frequently fed to cattle on account of its great yield. At Lyons it has been grown eighteen inches long and twelve inches thick. It is sowed in July and August, and requires for its full development a loose, well-manured soil, and frequent watering in September. —7 *C*, *March*, 1875, 35.

VALUE OF THE COMMON BROOM PLANT AS A FIBRE.

The common broom of Europe (*Spartium junceum*) is announced as furnishing a fibre equal and in some respects superior to that of hemp and flax. In view of the great extent to which this plant occurs wild in Southern Europe, and the ease with which it is cultivated, such application, not indeed new, but only more recently revived, promises important results. Its fibre can be very minutely divided, and, as it retains heat, it can supply the place of wool. It receives the most delicate dyes as well as an animal fibre, and successfully resists the action of acids and salt water without undergoing any change or losing its tenacity. Its strength is one third greater than that of hemp, while it is thirteen per cent. lighter. It can be furnished, delivered at the factories, for about £2 per ton. The fibre may be obtained by soaking the stems for a few days in warm water, or else by means of a chemical solution of little cost.—17 *A*, *March* 1, 1875, 41.

AUTUMN PLANTING OF POTATOES.

Experiments have been conducted in Paris with reference to a method of autumn planting of potatoes, by which new potatoes may be dug in January. The sets are planted in August on a thin layer of salt, which appears to be the special secret in the process, and the potatoes are earthed in September, the ground being cleared of weeds in October. The result is a crop of seven or eight fair-sized tubers to each root in January.—18 *A*, *February* 19, 1875, 575.

IMPORTANCE OF PEAT BEDS.

In some remarks on the climatology of New Hampshire, Professor Huntington states that the preservation of the vegetation on our mountains is of great importance, not only in modifying the distribution of rain, but also in modifying the extreme of cold in winter. Our mountains, especially the higher summits, are covered to a considerable depth, except where it has been destroyed by fires, by peat, formed chiefly from moss and lichens. Now it has been found by experiment that peat moss can absorb more than twice its own weight of water; dry clay, nearly its own weight; dry earth or garden mould, more than half its own weight, and dry sand a little more than a third of its own weight. With equal times of drying, under the same circumstances, therefore, peat moss loses two thirds of all the water it contained; clay and earth more than three fourths, and sand more than nine tenths. Thus, in a dry season, beds of peat must form an invaluable reservoir of water for the supply of springs and streams. Wherever it or vegetable mould abounds, the soil retains its moisture, being only gradually evaporated; a high relative humidity is maintained, and springs gush forth from the slopes of the mountains, and a slight change in the temperature causes rain to fail in gentle showers. It is noted that on the mountains of New Hampshire fires in general spread only over their eastern slopes.—*Climatology of New Hampshire*, 1874.

PREVENTION OF THE FREEZING OF FRUIT IN THE BUD.

The freezing of fruit in the bud, frequently occasioned by a few warm days succeeded by late frosts, it is said, may be prevented by spreading a thick layer of frozen manure, or of ice or snow, around the trees in February or March, while the ground is firmly frozen. The buds will thus be kept back, since the ground will thaw more slowly, and the roots convey no nutriment to the tree. When frosts are no longer to be feared the covering should be removed.—10 *C*, *August* 1, 1875, 123.

SMOKE AS A PROTECTION AGAINST FROST.

The production of artificial clouds of smoke is a common appliance against frost in France and Germany. M. Vinard recommended a plan which is perfectly successful, and which consists in carefully mixing gas tar with sawdust and old straw, and piling up this mixture in large heaps in the vineyards. The mixture remains inflammable more than a fortnight, in spite of rain and weather. When required for use smaller heaps are made from the large ones, about two feet in diameter, and distributed in and around the vineyard. If there is little wind these heaps burn freely for about three and a half hours, and produce a very dense smoke. The artificial cloud which thus enwraps the vines considerably decreases the radiation from the ground, and therefore prevents frost, which is greatest toward morning during calm spring nights.—12 *A*, XI., 396.

THE EVAPORATION FROM THE SKINS OF FRUIT.

By comparing the evaporation from apples with and without their outer skins, Just has arrived at the following conclusions: 1. The resistance which the skin offers to evaporation is quite energetic at low temperatures, but diminishes sensibly above the temperature of 46°, until it becomes barely sensible at 97°. 2. In the case of pared apples, a covering is formed from the dried exterior cells, which opposes rapid evaporation. 3. This exterior covering is formed gradually, so that its retarding influence is scarcely felt for the first twenty-four hours, during which time evaporation continues very rapid. 4. A similar covering of dried cells forms in the case of unpared apples only after the exterior layer of cells has dried up very much. The application of these results to preparing dried apples shows that for their rapid production in the best condition they must be dried at as low a temperature as possible after having been pared.—19 *C*, VIII., 15.

INFLUENCE OF THE SUN-SPOT PERIOD ON THE PRICE OF GRAIN.

Professor Jevons recently read an interesting paper on the influence of the sun-spot period upon the price of grain. In making a comparison between two phenomena apparently so distinct from each other Professor Jevons has made use of the collection of prices of commodities in England between the years 1259 and 1400, as published in Professor Rodgers' "History of Agriculture and Prices in England." He finds that the prices of each kind of produce rise during the first four of the eleven-year sun-spot period, and then fall. The maximum prices occur in the tenth, eleventh, first, second, and third years.

CULTURE OF CERTAIN PLANTS AMONG THE ABORIGINES.

The Bulletin of the Torrey Botanical Club contains a communication from Dr. J. H. Trumbull in reference to the evidence of the existence of certain vegetables in America at the time of the first visit of the whites. He quotes from Cabeca de Vaca, who found in 1528, near Tampa Bay, maize, beans, and pumpkins. Cartier, in his first visit to Canada in 1534, found beans and melons. Hudson, in 1609, when on the Catskills, was supplied with Indian corn, pumpkins, and tobacco. Champlain, on his voyage in 1604, found beans, melons, and tobacco on the Connecticut River. Purslane is also given as a substance known to the Indians in the earliest days.

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION.

A bill was not long since introduced into the Connecticut Legislature providing for the establishment of an agricultural experiment station on the plan of those which have proved so serviceable in Germany and elsewhere in Europe, and providing an annual appropriation for the purpose. This, however, failed to become a law. Mr. Orange Judd, the well-known editor and proprietor of the *American Agriculturist*, then with characteristic liberality offered on his own part $1000, and, on that of the trustees of the Wesleyan University, the free use of laboratories and appliances for the purpose in the Hall of Natural Sciences (given by himself to that institution), provided the Legislature would appropriate a sum of money for the establishment of a station. In answer to this the Legislature passed almost unanimously a resolution "to promote agriculture." The preamble to this reads as follows: "Whereas, the trustees of the university at Middletown tender the free use of ample laboratories, and other facilities for establishing and carrying on an experiment station for the general benefit and improvement of agriculture and kindred interests of the state of Connecticut."

The resolution provides "that the sum of seven hundred dollars per quarter for two years is hereby appropriated to the university located at Middletown, Middlesex County, to be used in employing competent scientific men to carry on the appropriate work of an agricultural experiment station," and directs the comptroller to pay the sum specified to the treasurer of the university, provided "the said treasurer shall satisfy the comptroller that such money is expended in the employment of scientific men for making the investigations and experiments contemplated in this resolution; and that the said university shall superintend such experiments, and shall provide ample laboratories and buildings therefor free of charge."

The station is now fully organized. Professor W. O. Atwater, of the university, Dr. W. C. Tilden, and two assistants are engaged in the work. An advisory committee of prominent farmers of the state has been appointed to give counsel in the management of the station, and to facilitate its connection with the public. Hearty sympathy and encouragement are manifested on all sides, and it is hoped that the first two years of its labor will prove so successful as in the future to insure from the state support commensurate with the importance of its object.

PROPOSED UTILIZATION OF FISH-BONES.

German manufacturers are continually engaged in purchasing fish-bones, gathered along the Norwegian shores near extensive fish-curing establishments. These are pulverized and converted into fertilizers. It is suggested that arrangements be made for utilizing the bones from the establishments in Newfoundland, such products of American fisheries, being estimated at 120,000,000 pounds per year.—23 *A*, XXII., 263.

WHAT POTASH SALTS TO BUY.

Professor Goessmann concludes that our dealers act in the best interest of their consumers by importing none but 80 per cent. containing muriate of potash, and 40 to 50 per cent. containing sulphate of potash, the former being equivalent to 50 per cent. of potassium oxide, the latter to 25 per cent. These compounds are the cheapest of their kind, and answer the requirements of both general and special farming. Our farmers do best as a general rule to ask for the higher grades of these fertilizers, and to use the lower grades, if cheap, only for forage crops.—*Rept. Sec. Mass. Board of Agric.*, 1874–5, 362.

WOOD-ASHES AS A POTASH FERTILIZER.

From a very elaborate and thorough investigation of the composition of wood-ashes from household fires, by Professor Storer, it appears that these contain, unleached and dry, about 8½ per cent. of potash, somewhat more than the lowest grades of German potash salts. Either leached or unleached, the dry ashes contain about two per cent. of phosphoric acid, of which none occurs in the German salts. In Storer's field experiments, wood-ashes (unleached) applied in large quantities brought larger yields of barley, beans, and rutabagas than farm-yard manure, city stable manure, or any single potash salt, as sulphate, carbonate, or even nitrate. In commenting upon these results, Storer says: "Wood-ashes are more serviceable than any single potash salt, not only because they contain some phosphoric acid, lime, magnesia, and the less valuable elements of plant-food, but because, considering them merely as a potassic manure, they contain a mixture of potash salts. It may be regarded as well-nigh certain that a given amount of potash, applied in the form of appropriate mixtures of sulphate, carbonate, silicate, and chloride of potassium, will, generally speaking, do more good than when applied in the form of either one of these compounds. But in wood-ashes we find a mixture of these salts ready at hand; not the best mixture, perhaps, but one already formed, and in this country at least very easily obtained."—*Bulletin Bussey Inst.*, I, 127.

VALUES OF POTASH FERTILIZERS.

The potassium in the German potash salts occurs either as potassium sulphate, "sulphate of potash," or as potassium chloride, "muriate of potash." It generally comes at a lower price per pound as chloride than as sulphate. But, as Professor Goessmann very justly remarks, there are other things besides first cost to be considered in buying these manures. Long experience in Europe has shown that the form in which the potassium is present, as well as the amount and nature of the other compounds that occur in the German salts, controls to a great extent their action upon various crops and soils. The sulphate of potash is unanimously approved as the safest potash compound—without regard to kind of crop—and as far as the quality of some of the industrial products are concerned. It increases the percentage of starch in potatoes, and of sugar in sugar-beets. It counteracts best, in common with nitrate of potassa, the tendency of tobacco to char and to smell offensively, thereby rendering it better adapted to smoking, and increasing its commercial value. Upon wet lands alone the sulphate is considered as unprofitable, and the chloride of potassium the safer article. The chloride of potassium, on the other hand, has not received such general commendation. Its use as a fertilizer for potatoes and tobacco has been decidedly discouraged, for it acts on these crops more in the direction of quantity than quality. It is, however, highly recommended for meadows, for pasture lands, and for all kinds of forage and grain crops, particularly when applied in connection with phosphates. The relative agricultural value of both series of compounds, chlorides and sulphates, is also frequently and in an unusual degree modified by the presence of certain other saline compounds, which are found associated with them in the mines.

Most prominent among these are sodium chloride (common salt), magnesium chloride, and magnesium sulphate. The presence—more than mere traces—of magnesium chloride is decidedly objectionable, for its action on plant growth in general is known to be destructive. It favors, also, the transformation of lime in calcium chloride, and thus assists in sending this valuable constituent down into the drainage water. A large admixture of common salt—(some of these fertilizers contain from 40 to 45 per cent.)—renders them unprofitable for the cultivation of the more important industrial crops (for instance, tobacco).—*Rept. Sec. Mass. Board of Agric.*, 1874–5, 358.

GERMAN POTASH SALTS.

The need of potash as a fertilizer has been impressing itself more and more, of late, upon farmers throughout the country. The discovery of the immense deposits of potash salts in the mines of Stassfurt, in Germany, and the beneficial results of their use as manure in Europe, have led to the importation of considerable quantities to the United States. Unfortunately, much of this imported material has been of the lower grades, which contain but little actual potash compound, the largest portion consisting of salts of soda and magnesia, and other materials of small agricultural value, among the rest, chloride of magnesium, which is actually harmful to vegetation. The amount of "actual potash," *i. e.*, potassium, reckoned as potassium oxide, in the German salts varies from seven per cent. in the lowest, to over fifty per cent. in the highest grades. Eight samples analyzed by Professor Goessmann contained respectively 7.97, 7.56, 8.72, 8.37, 9.18, 10.14, 16.21, and 50.30 per cent. of potassium oxide. The three lowest results were from fertilizers represented to contain 32.34 and 41 per cent. respectively. The two highest were nearly or quite equal to the dealers' guarantee. Not only were the poorer articles deficient in potash, but they contained considerable chloride of magnesium; and, further, the larger proportion of their potassium proved, as Professor Goessmann states, to be present in the form of chloride of potassium, and they belong consequently, without exception, to those low grades of German potash salts which are commonly called "Dung salts." . . . To buy these low grades of potash salts is, even in Germany, not considered economical on the part of farmers, for they have learned that whenever the cost of transportation of one hundred pounds of potassium oxide exceeds about sixty cents, the higher grades become the cheaper article. To pay an additional freight across the Atlantic on 1800 pounds of material, which we have in abundance and cheaper at home, for the purpose of securing 160 to 200 pounds of potassium oxide, can not be the best course to obtain a suitable supply.—*Rep. Sec. Mass. Board of Agric.*, 1875–6, 354.

THE COMPOSITION OF AMERICAN WHEAT PRODUCTS.

Important additions to our knowledge of the chemical composition and nutritive value of some of our common feeding materials for cattle have been made by Professor Storer, of the Bussey Institution of Harvard University, in analyses of Western shorts (bran), middlings, and shipstuff. Until lately very few trustworthy analyses of American vegetable products had been made, and it has been necessary to depend upon tables of European analyses for estimates of their composition. The names given to the by-products from the manufacture of wheat into flour vary in different parts of the country. "Shorts" and "bran" are generally synonymous. "Middlings" is usually applied to a meal-like product, ranking in composition and fineness midway between shorts and flour. The terms "millstuff" in Boston, "millfeed" in Chicago, and "shipstuff" in the South, seem all to apply to a mixture of shorts and middlings, which include every thing not flour that is separated from wheat. On comparing his own results with the most trustworthy European analyses, Professor Storer finds that these products in this country are somewhat dryer than the corresponding European ones. Three samples of Western shorts, for instance, average 11.65 per cent. of water, while the average of European bran was 13.24 per cent. This difference Professor Storer is inclined to attribute to the greater dryness of the atmosphere in this country. There was a similar difference in the amount of albuminoids, the average in American shorts being 11.75 per cent. and in European bran 13.44 per cent. For this two reasons are suggested. First, the flour, which, as is familiarly known, contains less albuminoid (nitrogen) than bran, is less completely separated from the bran here than in Europe. Second, Western shorts often lose weight in storage and transportation. In standing in heaps they not unfrequently "heat," and "shrink" to the extent of twenty per cent. of the original weight. In the process of fermentation, to which this is largely due, the albuminoids would be found to suffer decomposition and loss.

FURNACE FOR BURNING HAY, STRAW, ETC.

The necessity for some practical device whereby vegetable refuse of various kinds, such as straw, hay, dry leaves, seaweed, etc., may be conveniently utilized as fuel in those regions where coal is expensive and timber scarce, has long been recognized, and several attempts to solve the problem have been made. The following is a description of one of the most promising inventions for this purpose. It consists of a box of stove sheet-iron, in which is a heavy press follower, which by a simple mechanism can be moved up and down, and thus arranged to maintain a steady pressure upon the hay, or similar material, placed in the fire-chamber. The supply of fuel is regulated by a feeder, and a suitable attachment adjusts the grate relatively to the follower, according to the quantity of material placed between them. The inventor claims that by this arrangement, the fuel being under pressure, combustion can go on only around the sides to which the heat and air have access; the consumption of fuel is therefore very slow, and can readily be graduated by the draft supplied. One hundred pounds of hay or straw, it is claimed, will be sufficient to supply the stove during the coldest weather, and six or seven tons will suffice for an entire winter.—6 *D*, XXXIII., 119.

NUTRITIVE VALUE OF SHORTS, MIDDLINGS, AND SHIPSTUFF.

Analyses by Professor Storer show that these American wheat products are very valuable as food for domestic animals. In the latest tables of Wolff, of the Agricultural Experiment Station, at Hohenheim, in Germany, European bran is reckoned as worth twelve per cent. less than rye, and thirty-five per cent. more than average hay. The estimates are based upon the amounts of actually digestible food ingredients contained in them, certain values per pound being assumed for albuminoids, carbo-hydrates, and fats. Taking rye as the standard, and calculating what number of pounds would contain one dollar's worth of these ingredients, the same number of pounds of European bran would be valued at 87 cents, St. Louis "shipstuff" at 88 cents, and corn meal at 94 cents. The middlings and shipstuff contain less of albuminoids and fats, and more of carbo-hydrates than the shorts or bran, but must be a trifle more digestible. The estimated value would not differ greatly from that of the bran or shorts. "It is worth noting," Professor Storer remarks, "that the ash of bran (or shorts) contains an unusually large percentage of phosphates (over fifty per cent. of this ash is phosphoric acid, calculated as if it were free and uncombined), and that every ton of shorts or middlings contains from thirty to fifty pounds of ash. All the varieties of bran are consequently well fitted to supply the phosphates needed by milch cows and growing animals; and the manure from animals fed with bran will, of course, be especially rich in phosphates.—*Bulletin Bussey Institution*, I., 39–185.

SALT-MARSH AND BOG HAY: THE FEEDING VALUE.

Professor Storer has examined a number of coarse hays, including particularly several specimens of bog and salt-marsh hay, such as are commonly used for fodder and manure in New England. As regards chemical composition, these stand midway between ordinary upland hay and straw of the cereals. That is to say, straw contains in general less of albuminoids and fats, but more crude fibre (cellulose) than good hay. These coarse hays have less of albuminoids and fats than the hay and more than the straw, so likewise they contain more crude fibre than the hay and less than the straw. The practical bearing of these facts is very important. One great defect of our ordinary forage materials is a lack of albuminoids (nitrogenous material). Late investigations at the European experiment stations have shown that the functions of nitrogen in nutrition are more important than was formerly supposed, and that only the best qualities of hay contain as large a proportion of these as is required by milch cows, and for working and fatting animals for the highest production. The poorer qualities of hay, however, furnish a good deal of digestible and nutritious material, but are deficient in albuminoids. To use these coarse hays economically, other materials rich in digestible albuminoids should be added. Such are oil-cakes, beans, pease, bran, etc. And Professor Storer very justly remarks that "there are many places where it would be not merely good practice, but really excellent farming, to feed out upon the farm the hay from coarse natural herbage, with the addition of small quantities of the more concentrated forms of food, and send off from the farm, in so far as might be practicable, the more costly upland hay, to be marketed like any other merchantable product."

ARTIFICIAL DRYING OF HAY AND GRAIN.

Considerable interest has been excited in agricultural circles in England in regard to the apparatus invented by Mr. William Alfred Gibbs for drying hay and grain artificially during damp weather. The apparatus consists of a portable stove, constructed of plate iron, and is surmounted by a fan which is driven by a belt from a three horse-power portable steam-engine. The fan draws all the heated air and gases from the coke fire, together with a volume of warmed air, which passes through a chamber surrounding the inner chamber of the stove, and blows the hot current, at a temperature of 400° Fahr. or more, into the dryer. This resembles in general shape a straw elevator, consisting of a sheet-iron trough six feet in breadth, twenty feet long if mounted on wheels as a portable carriage, or forty or fifty feet long if a fixture. The trough is raised at one end at a low angle, so that hay fed in at the upper end farthest from the stove shall slowly travel to the lower end near the stove, this being assisted by a reciprocating motion given to the bottom of the trough. A ridge of triangular section, running along the middle of the trough, divides it into two almost semicircular channels, so that the hay passes down in two streams; the hot air issues through two slit apertures, one on each side of the base of the middle ridge, and for the entire length of the machine, and the hay is kept continually stirred and lightened up, over the hot blast, by a number of small iron stirrers contrived to imitate the action of forks worked by hands. The London *Times*, in an article on this subject, remarks of the experiment of Mr. Gibbs, that partly made but wet hay passed through the machine was converted at once into a thoroughly dry condition for the stack, and that spoiled and musty hay was dried into hay of fair apparent quality and pleasant fragrance; also, that freshly cut grass, saturated with rain from a heavy thunder-shower, was dried into hay of first-class color, possessing the rich malt odor of well-made hay. Mr. Gibbs, in bringing his invention before the public, claims that this new hay-dryer is as portable as a threshing-machine, and as quickly set to work; that, besides dealing with first and second crops of hay, it will dry all kinds of grain in the straw, and fit it for being threshed out at once if wished. He says one ordinary portable engine of eight or ten horse-power can dry and thresh out at the same time. The machine can be driven by either steam or water power, or by horse gear; and, in whichever way, it will save the labor of five or six men. Being thus a labor-saving machine, its use is not limited to that of final resource when other means fail, but it is available during every dull day of harvest for finishing off rapidly the most advanced of the hay or grain crop, and thus expediting as well as insuring the gathering. If three or four farmers purchased one such machine among themselves, and hired it out to each other in turn, those of them who did not need to use it would get ten per cent. on their share of the cost, while those who did need it would in all probability save the whole of their outlay the first season. The objection that all would want it at once is not so great as it seems, because it is very seldom that the farmers of a neighborhood have their crops in exactly the same state of forwardness simultaneously. Every practical man knows that in some seasons he has suffered great loss and inconvenience by bad weather, while his neighbors, from being a little earlier or a little later than himself, have saved their crops in good condition; in other seasons the case has been reversed; he has been fortunate and they have been caught. Moreover, it has been found that when half-made hay had been left out untouched in the rain for three or four weeks, until some parts were black and apparently worthless, the drying process restored the whole to a fair marketable quality. Hence, each farmer could safely wait his turn, so long as there was the satisfactory certainty of being able thus to complete his harvest. According to Mr. Gibbs's calculation, the total expenses, allowing for outlay and for wear and tear, does not exceed seven or eight shillings per ton.—2 *A*, XX., 64.

THE NEW PHYLLOXERA REMEDY.

La Nature, in a late review of the researches of M. Dumas relative to the practical efficiency of the alkaline sulpho-carbonates as destroyers of the phylloxera, affords us the following information upon the philosophy of the operation of this class of salts: The sulpho-carbonates of the alkalies are produced by calcining their respective sulphates with carbon, by which the mono-sulphide is produced, and agitating a concentrated aqueous solution of this with carbon disulphide. The sulpho-carbonates obtained as here described are free from disagreeable odor, are not dangerous to handle, are non-inflammable, and comparatively stable. In the presence of acids, however, even of the weakest, and notably when acted upon by the carbonic acid of which a moist, arable soil invariably contains a certain quantity, the sulpho-carbonates are decomposed into carbonates, with the liberation of carbon disulphide and sulphuretted hydrogen, both of which, and especially the first, are known to be highly efficient insecticides. It has been found that it is not only necessary to destroy the insects upon the vines and roots, but likewise to poison the earth in the vicinity of the same, and render it uninhabitable by them. For this purpose the sulpho-carbonates seem to be admirably adapted, inasmuch as, by their tardy decomposition, they furnish a slow but constant supply of the poisonous gases for some days. Experiments have shown that 1442 grains of the sulpho-carbonate of potassa will exterminate the insects from 198 to 284 cubic feet of earth, killing not only the phylloxera, but likewise the larvæ of larger insects. To apply the remedy, it is recommended to remove the earth from the foot of the vine about a foot deep and sixteen inches broad, into which is to be poured five or six quarts of water mixed with six or eight quarts of the sulpho-carbonate solution at 40° Baumé. When the liquid is well absorbed the hole is closed, and the same process gone through on another vine. By following this method the penetration of the solution to the deepest roots is insured. Another method of application proposed by M. Dumas is to mix the sulpho-carbonate with twice its weight of slaked lime, and to strew the powder thus obtained upon the soil wherever required.

RAVAGES OF PHYLLOXERA.

Among the various methods employed most successfully in France to prevent the ravages of the phylloxera, is the application of the sulpho-carbonates as originally suggested by M. Dumas. The sulpho-carbonate of potash has been experimented with most generally, and it is maintained that in addition to the destruction of the pest, it serves as a valuable manure to the plants, greatly increasing their vigor. More recently sulpho-carbonates of sodium and of barium have been tested, the former proving to be in every respect equal in efficacy to the potassium salt. In some respects it was found that the salt of barium was even better than the other, as it is quite reasonable in price, and as a mineral manure its action is much slower and more permanent than that of the other.—6 *B*, *July* 17, 1876, 213.

LATEST CONCLUSIONS RESPECTING PHYLLOXERA.

The most recent conclusions by Dumas in regard to the subject of the phylloxera, or grape-vine louse, and its remedies, are as follows: First, sulpho-carbonate of potassium is a rapid insecticide, the only one which surely destroys the insect at the roots, and also supplies to the vine a strong reconstituent element; second, sulpho-carbonate of sodium offers the same advantages, used only as insecticide; third, sulpho-carbonate of barium, being anhydrous and little soluble, is recommended for its resistance to the action of oxygen and of carbolic acid, so that it is a poison less prompt, but more durable in effect; with regard to the winter eggs, fourth, the heavy oil of gas-tar, and especially the oil called *anthracene*, seems to be best for washing the stocks and destroying the eggs; fifth, the treatment with tar for the stocks and sulpho-carbonates for the roots should be effected especially in February and March.—18 *A*, *March* 10, 1876, 658.

CARTRIDGES FOR THE DESTRUCTION OF FIELD MICE BY FUMIGATION.

According to Dr. Nessler, the cartridges recommended for destroying field mice by fumigation may be prepared by dissolving twelve parts of saltpetre in twenty-four parts of hot water, and mixing well with thirty parts of sawdust and seven parts of coal-tar, and drying in the air. This powder may then be made up with starch-paste (ten parts of starch to ninety parts of water) into a mass that can be formed into rods about four tenths of an inch thick and one inch long, which should be well dried, and sprinkled with melted sulphur. The mixing of the powder and making up of the mass with starch-paste is readily accomplished in a petroleum barrel, containing ten to twelve one-pound iron balls, and capable of being rotated on an axis passing through it lengthwise. The rods may be formed most rapidly by pressing the mass in sheet-iron moulds having a number of compartments of the proper size. Several thousand, it is said, can be made by a practiced hand in an hour. After drying, they should be spread out, and by means of a broom sprinkled with fused sulphur.—5 *C*, XXXII., 255.

MEANS FOR DESTROYING THE SIBERIAN MARMOT.

Among the smaller animals most injurious to vegetation in Siberia is a small marmot known as the soulish (*Spermophilus citillus*), closely allied to the species so common in Minnesota, Wisconsin, and Iowa, in the West, called there gopher, thirteen-lined squirrel, prairie squirrel, etc. In the department of Jekaterinoslaw they have lately become so abundant as to constitute a positive pest, and an order has been issued requiring each inhabitant to furnish a certain number of heads under penalty of a fine. In 1873, in five counties alone rewards were paid for the destruction of nearly six millions of these animals. By energetic measures of this kind alone has it been possible to prevent the almost total destruction of the crops.—3 *C*, XXXVI., 724.

THE FODDER VALUE OF APPLES.

In his investigation of the fodder value of apples, Professor Storer confirms the observations of other chemists, to the effect that apples are very poor in nitrogen. The flesh of Baldwins and Russets yielded 15.7 to 17.5 per cent. of dry organic matter (the rest being water and mineral matters), and only 0.21 to 0.27 per cent. of albuminoids. Apple pomace contained 22.3 per cent. of dry organic matter, and 0.98 per cent.

of albuminoids. Leaving the water out of account, the dry matter of the flesh of apples contains 1.43 per cent. of albuminoids, while the dry matter of potatoes has 8.54, and pumpkins 17.32 per cent. of albuminoids. From these facts two interesting conclusions are to be drawn. First, the small amount of nitrogen explains at least one reason for the low value of apples for feed and for manure; and, second, to make economical fodder from apples or pomace, food rich in nitrogen should be added. In this way not only the sugar, but also the pectose, of which apples are largely composed, may be economically utilized as food.—*Bulletin Bussey Institution*, I., 339.

THE TASTE OF TURNIPS IN MILK AND BUTTER.

It is stated, upon German authority, that the unpleasant taste imparted to milk and butter by feeding turnips, etc., may be removed by simply throwing into each pan of milk of four to five quarts as much saltpetre as will lie on the point of a knife, when a gelatinous mass will separate from the milk and settle to the bottom.—9 *C*, XIII., 107.

PRESERVATION OF HOPS.

Exhaustive experiments have demonstrated that hops, packed when fresh by means of a hand-press in strong, suitably constructed metallic boxes, and sealed up hermetically, can be preserved in any cellar with a temperature not above 48° or 50°, without manifesting the least inferiority to fresh hops in color, odor, or weight; and the beer made with them in summer is said to equal winter beer in flavor and fineness. —13 *C*, *December* 15, 1875, 1559.

NEW FERTILIZING MATERIAL.

Cabien recently called the attention of the Paris Academy of Sciences to the hitherto entirely neglected source of fertilizing material in the deposits left by every ebb-tide. He asserted that, after the detritus had been suitably ground, he obtained a powder consisting of calcareous phosphates, which, when mixed with an equal amount of liquid and solid fecal matter, afforded a manure containing 30 per cent. of easily soluble phosphates, 20 per cent. of nitrogen, and only 12 per cent. of insoluble ingredients, being as rich in nitrogen as Peruvian guano, and richer in phosphates.—3 *C*, *November* 1, 1875, 884.

POSSIBILITY OF PREDICTING THE COMING HARVEST.

Marié Davy, having studied the influence of the weather upon the vegetation in 1875 and 1876, concludes that there occur in the life of a plant two well-marked phases: first, the plant assimilates, and, second, it applies the reserved material to the formation of the seeds. In comparing the seasons of 1873, 1874, and 1875, he states that the study of the hygrometer and the evapometer, supplementing as they do the temperature, rain, and light, leads to the conclusion that if we have the meteorological data for the weather succeeding the time of blossoming of the plant, we can, according to the locality, estimate the probable value of the harvest that is to follow.—19 *C*, 1876, 100.

J. PISCICULTURE AND THE FISHERIES.

REPORT ON THE MARITIME FISHERIES OF FRANCE, 1874.

The report on the maritime fisheries of France for the year 1874 has just been published, showing that their general value amounted to about 73,000,000 francs, being nearly six and a half millions less than in 1873.

So far as the cod are concerned, there was a larger yield than before, although there was a reduction of twenty-five in the number of vessels in the fishing fleet. The herring-fishery was much inferior, nearly half of the general deficit relating to this fish. Among the causes of this decrease are named, first, a diminished demand for the fish; second, the later period at which the vessels started out for the fisheries; and, third, the abundance of fruit in the maritime districts, thus materially reducing the use of the herring. This decreased demand is considered a circumstance to be regretted, certain establishments which formerly consumed large quantities of herring now dispensing with them, especially in Alsace and Lorraine. There is no reason to believe that the fish have become any scarcer, nor that the means at the command of the fishermen are insufficient to secure a much larger yield; in fact, the use of cotton for nets instead of hemp, and improved apparatus generally, allow a greatly increased percentage of captures in proportion to the number of men.

Improved methods in the preparation of the herring are now strongly urged, so that an increasing demand may be secured, and thus an important industry be maintained at its utmost development.

The sardine-fishery of 1874 was also much less than that of previous years, in consequence of the diminished numbers on the coast.

Much satisfaction is expressed in the official report at the improvement in the department of oyster-culture, the production of Arcachon alone being nearly 82,000,000, or nearly double that of 1873, with a corresponding reduction of nearly one half in price.

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The actual number of men employed in 1874 amounted to 67,029, and of vessels of all kinds to 20,399, with an aggregate of 102,083 tons.—*Revue Maritime et Coloniale.*

REPORT OF BUREAU OF STATISTICS.

The annual report of Dr. Young, Chief of the Bureau of Statistics of Commerce and Navigation, for the fiscal year ending June 30th, 1875, has been published as a portion of the report of the Secretary of the Treasury, and forms an octavo of about 1100 pages. As usual, it is divided into three parts: first, Commerce; second, Immigration; third, Navigation. Under the head of commerce is given the usual series of tables of domestic and foreign imports and exports, with the duties levied, home consumption, shipments of domestic and foreign commodities and lumber, etc.

The products of the American fisheries and the imports from foreign ports are also given in the series of tables. The value of the American whale-fishery for the fiscal year mentioned is given at $2,841,002, this including 1,090,951 gallons of sperm and 1,414,186 gallons of whale oil, 328,217 pounds of whalebone, etc. The cod-fisheries are estimated at 756,543 hundred-weight, with a value of $3,664,496; the herring-fisheries at 527,633 hundred-weight, valued at $2,655,623. The entire yield of the American fisheries other than the whale-fishery is placed at $10,747,579, and the total value, including the whale-fisheries, at $13,588,581.

Comparing these tables of the whale-fisheries with those given by Messrs. Bartlett and Son, of New Bedford, for the actual imports during the year 1875, we find, according to the last-mentioned authority, that there were taken 42,617 barrels of sperm-oil, 34,594 barrels of whale-oil, and 372,303 pounds of whalebone.

GLOUCESTER FISHERIES FOR 1875.

The *Cape Ann Family Almanac* for 1876, published by the Gloucester *Telegraph*, contains some interesting notes in regard to the progress of the fisheries of that noted town. The extent of these may be judged from the fact that the total value of the fisheries for 1875 for the port of Gloucester amounted to $3,909,500, that of the whole district of Gloucester being $4,624,000. The whole number of vessels employed was 376, of which 108 were employed in the mackerel-fishery.

The most important item of the fisheries was that of the Georges cod-fishery, producing $1,021,000; next is the Banks cod-fishery, valued at $998,000; while the Bank halibut-fisheries were valued at $507,000.—*Cape Ann Family Almanac.*

CONNECTION OF METEOROLOGY AND HERRING-FISHERIES.

For some years past the Meteorological Society of Scotland has been endeavoring to ascertain the connection, if any, between the physical conditions of the atmosphere and the water of the sea and the appearance of herring on the coast of Scotland, this fishery being, as is well known, a very important interest in that country, and one employing a large capital and many men. The results of their labors, after a careful consideration of all the facts and conditions, may be summed up in the proposition that the "take" of herring is most abundant when and where the temperature of the sea is lowest. It was found that the temperature of the sea for the east coast of Scotland from the middle of August to the close of the fishing season was continuously and considerably higher in 1875 than in 1874; and that the catch of herring was continuously and considerably lower during 1875 than during the same period in 1874. When the temperature at the surface of the sea was high, the fish were found in the deeper parts of the water, preferring the lower to the higher temperature.

When a thunder-storm has prevailed on any of the days devoted to fishing, a good "take" of herrings may be expected, but on the following day few if any fish are caught on that part of the coast, unless at the extreme verge of a deep part of the sea, as if the fish were retreating thither. To settle these points on a more definite basis, and to give greater precision to their investigations, the Meteorological Society of Scotland desires the fishermen generally to observe the temperature of the sea at the surface and also at the depth at which the fish strike the coast, the amount of trouble involved in this being very incommensurate with the practical results that promise to be obtained therefrom. By a somewhat similar series of observations, prosecuted by Von Freeden, of

Hamburg, it was ascertained that northwest winds are best for large catches of herring, and northerly winds better than southerly, westerly better than easterly, also that moderately strong winds, sufficient to ruffle the surface of the sea, are better than calm weather, and light winds almost as unfavorable as stiff breezes. It is not impossible that, before long, the herring-fishery may be regulated by the thermometer, and that the net will be shot, not at random, as heretofore, but with an almost absolute certainty of finding the fish.

In further illustration of the influence of temperature on the herring-fishery of Scotland, we learn that during the week ending August 19th last the temperature of the water off the coast of Northumberland kept at from 58° to 59°, but that on the 21st it fell to 55°, and on that day herring were caught for the first time. Since then the shoals have been so great that several vessels have sustained heavy losses by the weight of the herring carrying the nets to the bottom.

During the whole of the warm weather of the past summer the catch of herring was very light, and it was not until the change of temperature that they came within range of the nets.—12 *A*, *August* 24, 31, 352, 381.

POTOMAC RIVER FISHERIES.

A writer in the Washington *Evening Star*, commenting upon the rapid decrease in the fisheries of the Potomac River, is disposed to assign the cause, as do many others, to the combined action of the gill-nets and shore seines which break up the schools of fish when on their way to the spawning-grounds, thus preventing the depositing of their eggs under circumstances favorable to their development. He strongly urges the propriety of having the deep channel of the Potomac marked out, and the introduction of nets of any kind therein prohibited under some stringent enactment, this channel to be wide enough to permit sea-room to vessels sailing against the wind—half a mile is suggested—and so buoyed and staked out that its location shall be unmistakable.

A similar action in the harbor of New York has resulted in preventing the destruction of the fish, and allows them to pass up in sufficient numbers to perpetuate their species.—*Evening Star.*

SEAL-FISHERIES OF 1876 ON THE GREENLAND COAST.

The seal-fishery off the coast of Greenland, as prosecuted by vessels from Dundee, Scotland, has proved to be more remunerative during the spring of 1876 than that of the preceding year, eleven vessels having taken 53,776 seals and 578 tuns of oil. In the preceding season twelve vessels took 45,295 seals, yielding 455 tuns of oil. The total value of this fishery for 1876 amounted to £34,332; that of 1875, to £27,026.

The Norwegian Greenland fisheries for the year have also been very successful. One peculiar feature of the year has been the number of old seals taken early in the season, showing that the work began too soon, as the young must have been very small.

CLOSE TIME FOR SEALS IN THE NORTHERN SEA.

Negotiations under way between the governments of Great Britain and Norway in reference to the time for the capture of seals on the Greenland coast have at last been consummated by the adoption of an Order in Council fixing the 3d of April in each year as the date before which no British subject shall kill or capture seals within the specified area. It is hoped that these restrictions, if fully carried out, will soon put an end to the barbarous destruction of infant seals.

REPORT ON ALASKA SEAL ISLANDS.

The subject of the Alaska fur-seal fishery is one of considerable importance in view of the revenue derived by the United States from the Alaska Commercial Company for the rent of the islands. Since the lease to that company numerous complaints have been made from time to time of its management; and in 1874 an act was passed to appoint a commission to visit the North Pacific with a view of determining whether there are other localities where the fur-seal can be found, and a clause was introduced directing the investigation by an officer of the navy into the management of their trust by the Alaska Commercial Company, and their treatment of the natives.

Mr. Henry W. Elliott was put in charge of the former object of the expedition, and Lieutenant Maynard was detailed for the latter. Mr. Elliott's report was published some time ago; that of Lieutenant Maynard has just made its appearance under a call from the House of Representatives of the 14th of December.

MENHADEN-FISHERY IN 1875.

From a recent report of the United States Menhaden Oil and Guano Association, presented at its third annual meeting at Providence on the 12th of January last, we learn that the number of factories in operation in 1875 was sixty, being four less than in 1874; that there were 2633 men employed, an increase of 194. The number of sailing-vessels was 304, an increase of 21; the number of steam-vessels, 39, an increase of 14. The fish caught in 1874 amounted to over 463,000,000, or 1,877,767 barrels, an increase over the number in 1874 of 734,840 barrels. Of oil, 2,681,487 gallons were made in 1875, and 43,620 tons of guano. The capital invested for 1876 is $2,650,000, an increase of $150,000 over that of the previous year.

Reference is made to the announcement by the Hon. S. L. Goodale, of Saco, Maine, of a practical application of menhaden in the form of a fish-extract for medicinal and culinary purposes; this substance, as derived from menhaden, being considered especially nutritious and palatable. This promises to add a very great element of value to the menhaden industry, without in any way affecting the availability of the crop for the manufacture of oil and scrap.

As the result of experiments of shipments of scrap during 1874, it was announced that 4000 tons had recently been forwarded to Liverpool and Queenstown. It was resolved that all guano and scrap manufactured by members of this association shall be sold at the weight taken at the factory of the seller.

NEW USE FOR THE SCRAP OF THE MOSS-BUNKER.

The applications of the moss-bunker, menhaden, or pogy, a well-known fish of the herring family, in the manufacture of oil and guano are well understood. The fish when taken for this purpose is first steamed and then subjected to a heavy pressure, by which the oil is squeezed out, and the refuse or scrap left behind. The oil is used in the manufacture of soaps, the dressing of hides, etc., while the scrap is converted into fertilizers of various kinds.

It is now stated that a new use has been found for this scrap, namely, that of employing it as a source whence a large amount of ammonia and other nitrogenous products may be obtained. This is accomplished by a certain process of treatment with lime. It is proposed to prepare from this substance a sulphate of ammonia, by treating it with sulphuric acid of the refineries of petroleum. Doubtless other chemical products will also be attempted.

The menhaden is also put up in oil in numerous establishments in New Jersey, and sold as the American sardine, ocean trout, etc., and sometimes is also put up in spices and pickled.

Mr. Goodale, of Maine, has recently suggested another application of this fish, in the preparation of a meat juice, which he claims to be extremely palatable and nourishing, quite equal in this respect to any of the articles of a similar kind known in the trade, while at the same time the value of the fish for oil and guano is undiminished.—*Letter of Dr. Squibbs.*

UTILIZING THE OFFAL OF CODFISH ON THE GULF OF ST. LAWRENCE.

M. Levy has lately started an establishment at the French island of St. Pierre, in the Gulf of St. Lawrence, for the purpose of utilizing the gurry and offal of the codfish, etc., taken on the banks of Newfoundland. All the heads, entrails, etc., are gathered in, and after the extraction of the oil, the bones are converted into gelatine and superphosphates. There are two factories of a similar character in Norway, one at the Loffoden Islands and the other at Christiania.—8 *B*, *August* 21, 1875, 192.

REPORT OF THE COMMISSIONER OF FISHERIES OF CANADA, FOR 1875.

The report of the Commissioner of Fisheries of Canada, for the year ending December, 1875, has been recently published by the Dominion authorities, and embraces an account of the general yield of the fisheries for the year, imports and exports of fish, the staff of officers, the methods taken for multiplying the whitefish, salmon, etc., the development of the waters, and a consideration of the oyster-beds, lobsters, etc. According to Mr. Whitcher, the product of the fisheries generally was less than that in 1874, this being especially true of the salmon and lobster. The total value of the production for 1875 was $10,347,886; the value of the exports during the fiscal year was $134,753. Notwithstanding this decrease, the Commissioner expresses himself as satisfied with the result, the fishing population having enjoyed prosperity, with a good prospect of increased yields in the future. According to the report, the Dominion government has now in operation seven establishments for the artificial propagation of fish. In addition to those at Newcastle, Gaspé, Restigouche, and Miramichi, three others have been erected; at Sandwich on the Detroit River, at Tadousac on the Saguenay, and at Bedford on the Sackville River, not far from Halifax. The total number of young salmon distributed from the hatching of 1874 was 1,700,000, and a much larger number is hoped for hereafter.

REPORT OF THE FISH COMMISSIONERS OF MAINE.

The Fish Commissioners of Maine have published their report for 1875, being their ninth annual report, and, as might have been expected, much space is occupied therein by the subject of the salmon and land-locked salmon, in regard to which they have made the usual progress by means of the hatching establishments at Bucksport, Grand Lake Stream, and elsewhere. They refer to the remarkable scarcity of salmon on the coast during the year 1875, a condition prevailing both in the United States and throughout the British Provinces, and they suggest that the much greater abundance during the year before indicates something similar to what we see in certain fruit crops, which usually show a regular period of abundance and scarcity in successive years. They say that very possibly the salmon have a two years' period of return to their native waters for the purpose of spawning, instead of one — a suggestion heretofore made by good observers.

Of the fry of the salmon, 700,000 were distributed, 100,000 being those of the California species. The growing interest in the land-locked salmon has also been responded to by the Maine Commissioners. During the past year many eggs were secured at Sebec Lake, and a still larger number at Sebago and Grand Lake Stream, and, it is to be hoped, with satisfactory results.

The distribution of black bass has been continued by the Commissioners, and they warmly recommend this fish for waters already infested with pickerel, which they can successfully resist, even if they can not exterminate them.

Reference is also made to the blue-backed trout, *Salmo oquassa*, and to the land-locked smelt, and the propagation of both strongly urged. A good deal has been done by the Commissioners in reference to distributing the former fish, now confined to the Rangeley lakes and other streams and ponds of the state.

The subject of fish-ways is one that the Commissioners consider requires further legislation, in view of the strenuous and hitherto successful resistance to the laws already enacted by mill-owners on certain streams of the state.

REPORT OF THE FISH COMMISSIONERS OF NEW HAMPSHIRE.

The report of the Fish Commissioners of New Hampshire, made to the Legislature at the June session of 1876, gives an account of the work done by these gentlemen in the performance of their trust. The small amount of money at the command of the Commissioners prevented the accomplishment of all that was desirable, but they have made some progress in the distribution of black bass, and in introducing the wall-eyed pike. They report a considerable amount of progress in the restoration of salmon to the waters of the state, and look forward to a future increase in the supply as a matter of much interest to the people.

TENTH REPORT OF THE MASSACHUSETTS FISH COMMISSIONERS.

Of the series of reports of the Fish Commissioners of the several states, none are more important than those published by Massachusetts, of which the tenth, for 1875, has been issued.

Upon the much-contested question of the efficiency of the fish-way at Hadley Falls in permitting the passage of shad, the Commissioners maintain that the problem has been solved satisfactorily in the affirmative; and as the result of a careful examination, they state that a great number of fish, such as suckers, black bass, etc., have passed through, and that quite a number of yearling shad were among the number, with only one mature fish.

Although the dam has been in use for some time, the fact that no shad for several years were seen to ascend it was seized upon as an argument in opposition to the assertion of its efficiency. This, however, was met by the theory, now well established, that anadromous fish ascend to the point whence they commenced their downward journey to the sea, and no higher, and that consequently, as no shad had been hatched or placed as young fish in the water above Hadley Falls, none would attempt to go above as mature fish. But as for two years past young shad have been hatched below the dam and carried to the waters above, the Commissioners think there is no reasonable doubt that the yearling shad in question were of the number. In another year we may, therefore, anticipate the passage of adult fish.

The other fish-ways in the state, as on the Merrimac, the Neponset, the Taunton, and the Palmer, have also proved to be efficient. Shad-hatching in 1875 was conducted as heretofore on the Merrimac, the whole number of shad taken therein amounting to 1433, and of spawn to 6,670,000. The catch of shad during the past year in the Merrimac was larger than it had been for twenty-five years previous, they being so abundant that at Newburyport they were salted and barreled as in olden times. This is considered by the Commissioners as very satisfactory proof of the beneficial results of artificial culture.

The report is accompanied by a valuable sketch of the progress of fish-culture in New England, and also a bill proposed for the regulation of the shore fisheries of the state.

TENTH REPORT OF THE FISH COMMISSIONERS OF CONNECTICUT.

The tenth report of the Fish Commissioners of the State of Connecticut was presented to the Legislature at the May session; and as giving the history of the efforts of the first decade in the restoration of fish to the waters of the state, they take occasion to review what has been done from the beginning under state patronage.

The Commissioners remark that Massachusetts, in 1856, was the first state to appoint Fish Commissioners to consider the subject of artificial propagation, but that no practical result followed. In 1864 New Hampshire and Vermont, in 1865 Massachusetts, and in 1866 Connecticut, appointed Commissioners to investigate the whole subject; and on the 26th of February, 1867, a meeting of Commissioners was held in Boston, and the organization of "The New England Commissioners of Inland Fisheries" was formed, with the special object of co-operation in restocking the Connecticut with salmon and shad. In this New Hampshire was to procure and distribute impregnated ova of salmon and shad in the head-waters of the river. Vermont and Massachusetts were to build suitable fish-ways over the dams to the spawning-grounds, and Connecticut was to abolish gill-nets, stake-nets, and pounds in the river and on the Sound. These measures of co-operation were carried out as fully as the various circumstances would permit.

The first experiments in the artificial hatching of shad were initiated by Seth Green at Holyoke in July, 1867. In the following winter the first lot of salmon fry, about 20,000, were placed in the head-waters of the Connecticut. The operations in New England generally and those in Connecticut especially in succeeding years are enumerated.

As will be noticed by a perusal of this very important report, no state has done more than, if so much as, Connecticut for the culture of the useful food fishes; and the result is already seen, as far as the Connecticut River is concerned, in the existence of an actual glut of the market with shad.

So far no positive return has been experienced in regard to salmon, but this was not expected before the year 1876, and possibly 1877. We hope the next report of the Commissioners will exhibit a measure of success in this direction that will satisfy the most doubting skeptics.

EIGHTH REPORT OF THE FISH COMMISSIONERS OF NEW YORK.

The eighth annual report of the Fish Commissioners of the State of New York, for the year ending December 31, 1875, has made its appearance. In regard to shad, it is stated that nearly 4,500,000 young fish were turned loose into the

Hudson River; and the yield of mature shad shows a fair increase in the number, and a very decided effect upon the price, large fish being readily procured in New York and in the towns of the state for twenty to twenty-five cents each—a rate which had not been known for twenty years previous.

The Commissioners continue their complaints of the violation of the law by fishermen, and state that the yield would otherwise have been very much greater. They urge that no fishing shall be done from Saturday night until Monday morning, and that the raising of all nets fastened to stakes be insisted upon during that period.

In reference to shad deposited in the tributaries of Lake Ontario, they remark that full-grown fish of marketable size have frequently been taken, and that in all probability the supply would be abundant but for the destruction wrought by the eel-weirs, which they consider among the most injurious agencies in interfering with the successful prosecution of the work. Indeed, according to the report, the shad artificially introduced into Lake Ontario have multiplied until now they amount to millions, and the fishermen think that if they continue to increase as they have done, the fish will be so abundant as not to repay them for their labor.

The Commissioners report that 304,000 California salmon, received from the United States Fish Commission, have been distributed during the year. They also detail the result of experiments in regard to the artificial hatching of sturgeon, which were successfully made by Mr. Seth Green. The eggs are sticky, as in the perch, and required some peculiar manipulation for their treatment, and a special apparatus was devised for the purpose, which it is thought will accomplish the object. The time of growth proved to be a hundred hours, in water at a temperature of from 67° to 74°.

The Commissioners continue to call attention to the destructive influences of fish-weirs and other agencies, and invoke legislation for their regulation, if not for their entire prohibition.

The report contains the statistics of the hatching of shad, as also the distribution of fish from the state hatching-house, and concludes with a general summary of the history of fish-cultural operations in other states.

FIFTH ANNUAL REPORT OF THE FISH COMMISSIONERS OF NEW JERSEY.

The fifth annual report (for the year 1874) of the Commissioners of Fisheries of the State of New Jersey contains a notice of the work done during that year. The report refers in appropriate terms to the death of Dr. J. H. Slack, one of the oldest Commissioners of the state, and one of the most successful fish-culturists in this country. In reference to shad—the most important fish of the Delaware River—the report states that the catch during the year 1874 was 50 per cent. more than in 1873, and that the average weight of the fish was considerably increased. This was ascribed to the better observance of the fishery laws for the past three seasons, especially that requiring a weekly close time of thirty hours, and also to the removal of fish-baskets in the Delaware, by which great numbers of young fish had heretofore been destroyed. The Commissioners urge the enforcement of the law in reference to this class of obstructions, and others of greater or less moment. A very important feature in the report consists in the reprint of the laws enacted by the Legislature of New Jersey, in reference to the concurrent rights of New Jersey and Pennsylvania over the fisheries of the Delaware; and also the agreements on the subject entered into by the representatives of the two states at various times.

SIXTH ANNUAL REPORT OF THE FISH COMMISSIONERS OF NEW JERSEY.

The sixth annual report of the Commissioners of Fisheries for the State of New Jersey, for the year 1875, has also been published, giving an account of what has been accomplished under their auspices. For greater convenience, they divided the state into the tidal or southern department and the non-tidal, each having special representatives in the board.

They are happy to state that, in consequence of the care bestowed upon the fishing interests by the enactment of laws and their enforcement by the Commissioners, the catch of shad is becoming greater in numbers and of larger size in each successive year, the fishing in the bay having been extraordinarily successful in 1875. Two hundred and fifty shad were taken at one drift, and the average per net was double that of the preceding season.

The quality fully corresponded with the increased numbers, shad of eight pounds having been captured. Notwithstanding the great increase, the fish kept up in price satisfactorily; and the fishermen themselves admitted that the improvement in the fishing is due to the enforcement of the laws, and are much more ready to accept them than formerly; in fact, every where the report confirms the statements of the increase referred to.

The Commissioners make a distinction between the work done by the gilling-nets and the shore or sweeping seines. They also state that the shad-fishing commenced unusually late in 1875, and that the fish entered the bay in immense numbers, but were kept in the brackish water by the continued cold weather, and were taken there in great numbers by the drift nets. The shore fishing did not commence until the 26th to the 28th of April, more than two weeks later than usual.

Reference is made to the concurrent action of New Jersey and Pennsylvania in regard to the hatching of shad in the Delaware River, the total number hatched at the several stations amounting to 1,400,000, at a cost of $937.20.

ACTION OF THE KENTUCKY FISH COMMISSIONERS.

Among the commissions appointed in the different states having for their object the protection and increase of fishes throughout their borders, none promises to be more enterprising and efficient than that of Kentucky, established by an act of March 20, 1876. The number of Commissioners is much larger than usual, being one for each Congressional district, or ten in all. The Executive Committee consists of Messrs. P. H. Darbey, John A. Steele, J. H. Bruce, Dr. S. W. Coombs, and Pack Thomas, the latter gentleman being president and executive officer of the board.

An address has just been issued by the Commissioners to the people of Kentucky, publishing the act, and making many suggestions in regard to the future of the Commission and the results to be attained.

Extracts from various reports of National or State Commissioners are given, including the whole of the annual report of the Commissioners of New York for the year 1874, with its many interesting illustrations of hatching establishments, fishes, etc.

CONVENTION OF WESTERN STATE FISH COMMISSIONERS.

A convention of the State Fish Commissioners of Ohio, Michigan, and Wisconsin met at Detroit on the 7th of February, for the purpose of determining upon conjoint legislation for the protection of the fish of the waters belonging to these several states. Among those present were Governor Bagley and Mr. George Clarke for Michigan, William Welch for Wisconsin, and Mr. E. B. Potter for Ohio. It was determined to recommend to the respective state legislatures the passage of laws prohibiting the discharge of refuse from distilleries, coal-oil refineries, or gas-works into any of the lakes or rivers; second, to prohibit the catching of whitefish and lake trout in pound-nets during the period from November 15 to September 10; third, to prevent the catching of any fish with gill, drag, or float nets within ten miles of the shores of any of the great lakes; fourth, to prohibit the catching, killing, or offering for sale of whitefish of less than one and a half pounds' weight; fifth, that pound-nets shall not extend over one mile from a base-line of seven feet of water into the lake, provided that they may, in the bays and indentations along the shore, extend one and a quarter miles from such base.

FIRST REPORT OF THE IOWA FISH COMMISSIONERS.

The first report of the Iowa Fish Commissioners, for the years 1874 and 1875, gives an account of their organization for the purpose of carrying out the trusts confided to them.

Among the first business transacted by them was the establishment of a hatching-house near Anamosa, under direction of B. F. Shaw. In this much work has already been done in the way of hatching out spawn of California salmon and other useful fishes. The total amount of spawn handled and of fish distributed by the state, consisting of California salmon, Penobscot salmon, etc., was nearly two millions, of which a good account, it is hoped, will be received in future years.

SECOND REPORT OF THE COMMISSIONERS OF FISHERIES OF WISCONSIN.

The second annual report of the Commissioners of Fisheries of the State of Wisconsin for 1875 has been published. It opens with the mention of some interesting facts in connection with the fisheries of Lake Michigan, and suggests the appointment of Dr. Hoy, one of the Commissioners, to prosecute similar inquiries on a large scale during the present year. The fisheries of the lakes, in the opinion of the Commissioners, have fallen off in 1875 by at least one fourth; and if this rate be continued but a few years, this great interest of Wisconsin will become practically exhausted. They therefore urge strongly the necessity of immediate action in regard to measures for the protection of the various species of fishes of the state for a few years, and the importance of efforts to multiply them and add new ones on the largest possible scale.

The Commissioners, owing to the scanty funds at their disposal, have been unable to accomplish much in the way of the active prosecution of their duties beyond the laying of foundations for future judicious work. One of their enterprises was the collecting of the eggs of the Mackinaw trout, of which it was found impossible to secure ripe spawn in any considerable quantity. Some eggs of the whitefish, however, were taken, as well as of the lake herring, which were hatched out at a temporary hatching-house improvised by the Commissioners at Pensaukee, on Green Bay.

SECOND REPORT OF THE FISH COMMISSIONERS OF MINNESOTA.

The Fish Commissioners of Minnesota have presented their second annual report, through Dr. R. O. Sweeney, the chairman, giving an account of what they have done in the way of hatching out the eggs of California salmon, the Atlantic salmon, and the land-locked salmon, furnished to them by the United States Fish Commission, specifying also the localities in which the young were planted after being developed.

They propose to continue the work, if suitable provision can be made, until every lake and stream in the state shall be made to yield its full proportion of food. They estimate the water surface of the state to be over 1,600,000 acres;

and making the very moderate allowance of a possible annual yield of ten pounds of fish to each acre, worth five cents per pound, the sum of $80,000,000 would represent the actual income to the state from this source, which is more than equal to a two years' yield of the wheat crop in Minnesota.

The Commissioners also propose to do what they can for the multiplication of whitefish, Lake Superior trout, eels, etc.

ARKANSAS FISH COMMISSIONERS.

The State of Arkansas has passed an act, approved November 29, 1875, for the appointment of three Commissioners to consider the subject of introducing sea-fish into the rivers of Arkansas, and the introduction of new varieties of the fresh-water species, as well as the protection of fish generally in Arkansas waters, and report on the same to the next session of the Legislature. The gentlemen appointed as Fish Commissioners were Messrs. M. H. Dunn, of Pine Bluffs, J. R. Stedman, of Little Rock, and N. B. Pearce, of Fayetteville.

BIENNIAL REPORT OF THE CALIFORNIA FISH COMMISSION.

The biennial report, for the year 1874–75, of the California Fish Commission has been published, and gives an account of the labors of Messrs. Redding, Throckmorton, and Farwell in the administration of the trust confided to them by the state. Referring to their previous report for the account of an unsuccessful experiment at introducing fresh-water and marine fish of the Atlantic slope to California by means of an aquarium car, they have the pleasure of announcing the entire success of the renewed effort on the part of Mr. Livingston Stone.

Among the principal fish thus introduced were 173 full-grown spawning black bass placed in Napa Creek; 16 full-grown wall-eyed perch (*Lucioperca*) placed in the Sacramento; 56 large Schuylkill cat-fish and 18 Mississippi cat-fish placed in the San Joaquin, near Stockton; 70 horned pout in Sacramento County; 12 eels in a lake near Sacramento; 305 small Eastern salmon in the Sacramento; and 4 full-grown black bass in Napa Creek.

Of salt-water fish, twenty-three tautog were deposited in the bay of San Francisco. The experiment with lobsters was not so successful; of 150 full-grown individuals, only three arriving alive, which were also placed in the bay of San Francisco. About 1500 small salt-water eels were introduced in the same locality.

The Commissioners are satisfied that most of the species introduced have found congenial quarters, and will before long be heard from. Large numbers of young black bass have already been detected, as also some of the wall-eyed perch. The cat-fish have grown rapidly, the young of which are frequently seen. The horned pouts have increased so rapidly that nearly one thousand have been taken out and transferred. They were placed in lakes containing brush and dead trees, so that they could not be seined out. Of the fresh-water eels, one has been taken which had grown to be more than a foot in length.

A large number of whitefish eggs, furnished by the United States Fish Commission, were placed in Tulare Lake. Many eggs of the brook trout have also been transferred to the West. Nothing further has been done in the way of shad, although the Commissioners hope at another season to have a donation of young fish from the United States Fish Commission.

The Commissioners also refer to their co-operation with the United States on the M'Cloud River to multiply salmon in the Sacramento, $2000 having been contributed by Governor Stanford and Mr. Charles Crocker, by means of which it is expected that between two and three millions of young will be hatched and turned into the river. They think that the true interest of California is in increasing the numbers of her native fish as well as in introducing those from abroad, and they design to keep up their efforts to stock the Sacramento until an abundant supply shall always be insured.

They figure up 4,000,000 pounds of salmon as having been shipped from the Sacramento River between the 1st of November, 1874, and the 1st of August, 1875, not including what had been sent East and otherwise disposed of. Numerous important recommendations are brought forward by the Commissioners for the protection of the interests committed to them. Among others, they would have the laws for the protection of seals and sea-lions rescinded, as these animals destroy myriads of valuable fishes. They also urge that some restriction be made in regard to the capture of fish, especially in salt water, at improper times and by improper methods, referring to the very great numbers of young fish destroyed wantonly and unnecessarily by the methods of fishing practiced by the Chinese.

CULTIVATION OF CARP IN CALIFORNIA.

Mr. J. A. Poppe, of Sonoma, California, calls the attention of the farmers of the United States to the subject of carp raising, in which he refers to his own experiences in the introduction of this fish into the country. In August, 1872, he arrived at Sonoma from Germany with five small carp, six inches long, all in very poor condition, one dying as it was placed in the water. In the following May he states that the fish had grown to be sixteen inches long, and had produced over three thousand young fish. He now has a very large stock, and all that he can send to market sell readily at one dollar per pound as an article of food, and he has no difficulty in disposing of all the living fish he is willing to spare at five dollars each. He remarks that when well fed the fish will grow one inch per week for the first two or three months, after which the growth in length is slower, but they increase in weight very rapidly.

CAPTURING EELS IN COCHIN CHINA.

An ingenious device is practiced in Cochin China for the capture of eels, which consists in cutting pieces of bamboo as thick as the arm into sections of about three or four feet in length, the divisions of the interior being broken out, with the exception of the one at the end, which forms the bottom of the snare. At the entrance is placed a slight grating of bamboo, and some bait, either of fish or earth-worms, is introduced into the interior. The bamboo is then laid at a slight depth in the mud, and the eels enter the hollow tube, in which they can scarcely move, and can not turn themselves, and are consequently taken captive. The bamboo is taken up every morning, and the eel, which holds on very firmly to the interior, is pulled out by means of a strong hook.—10 *B*, *June*, 1875, 290.

HATCHING WHITEFISH IN THE DETROIT RIVER.

The most gigantic enterprise in the way of the artificial multiplication of fish is that just now in progress on the Detroit River by the Fish Commission of Michigan and that of Canada. It is well known that of all the fishes in the lakes the whitefish is the most important, and that upon its pursuit and capture is based a very important interest, which occupies a large number of men and an immense capital. This, however, is one of the species most readily affected by overfishing, localities which furnished an ample supply a few years ago being now almost entirely exhausted.

When the Fish Commission of Michigan was organized, a few years ago, its attention was early directed toward measures for restoring the whitefish to its original abundance, and more if possible, and various propositions were made, some of which looked toward special restrictions in regard to the mesh of nets, time of capture, etc. It was found, however, that all the enactments for this end would be very difficult of execution, and it was finally concluded to endeavor to increase the numbers of fish by artificial propagation to such an extent as to make it unnecessary to pass any restrictive laws. Partial efforts to this end have been previously made; but it was during 1875 that the work has been commenced on a really vigorous scale. At present the Commissioners have between 6,000,000 and 8,000,000 whitefish eggs in their new hatching establishment recently erected at Detroit, all reported to be in excellent condition, and likely to become vigorous fish, to be introduced into the waters of the lake during the coming year. Indeed, it is thought that by a new improvement, lately devised, it will be possible to hatch 30,000,000 the next year.

While this work is prosecuted satisfactorily by the Commissioners of Michigan, a similar enterprise is carried on by Mr. Samuel Wilmot on the Canadian shores opposite, who will probably hatch out 5,000,000 to 8,000,000, and who also expects to reach a minimum of 20,000,000 another season.

The importance of these enterprises can not be easily overestimated. It may be calculated that of each million of young fish placed in the waters, not less than 200,000 will attain a full maturity, and possibly a much larger percentage. The expense is a mere trifle in proportion to the results to be anticipated, and it will probably be found more economical to continue the work indefinitely than to trust to natural reproduction on the part of the fish themselves, or to protective measures, however stringent, for the future supply.

Another state equally interested in the object in view with Michigan and Canada is Ohio, and her Commissioners have also been doing what circumstances would permit them in the same direction. They have established four hatching-houses — one at Cleveland, in connection with the water-works; one at Castalia Springs, near Sandusky; one at Toledo, in connection with the water-works; and one on Kelly's Island, in Lake Erie. So much time was occupied in getting these stations ready that the Commissioners could not procure a large stock of eggs, but expect to do their full share another season. In this emergency the Michigan Commissioners generously presented them with 800,000 whitefish eggs, which have been distributed to the different establishments to be hatched out.

ONE CAUSE OF DEATH OF FISHES.

In inquiring into the cause of the death of many fishes, M. De la Blanchere considers this largely connected with the exhaustion caused during reproduction, and calls attention to well-known facts in the history of large trout under such circumstances.—19 *B*, *June* 10, 188.

RAPIDITY OF GROWTH IN CERTAIN FISHES.

Mr. Mitchell, in a communication to *Nature*, presents some remarkable facts in regard to the rapidity of growth of fishes. Referring to a species of carp, called by the natives *Katlah*, he states that this is a species that does not breed in fresh water, but that the natives are in the habit of introducing the fry into ponds, etc., where they thrive very satisfactorily. According to his account, a tank sixty-five feet long, fifty-eight feet broad, and thirteen feet deep was dug within the premises at Garden Reach, in May, 1875, and a number of the *Katlah* fry, from half an inch to an inch in length, were introduced about the end of July. On the 22d of September the tank was swept with nets to catch one or two fish of the pike species that had been accidentally introduced with the others. In the net were taken several dozens of the carp referred to, one of which weighed fourteen ounces, and was eleven inches in length. Others were only a few ounces lighter. The food supplied to these fish consisted, in addition to the natural vegetation of the pond, of the refuse of rice and other substances thrown into the pond by the natives.—12 *A*, *December* 9, 107.

UTILIZATION OF WARMED WATERS IN FISH-CULTURE.

An important suggestion has been made in regard to the utilization of certain waters in the cultivation of fish, hitherto supposed to be unavailable. The author refers to certain ponds along the Rhine, connected with a variety of manufacturing establishments, which are intended to receive the water condensed by steam-engines. One of these ponds is about one hundred and twenty feet in length, with a depth at the sides of four feet, running down to sixteen feet in the centre, and is supplemented by the dike which runs around three sides of the manufacturing establishment. This dike in the aggregate is about 1600 feet long by twelve feet wide, and is six feet deep in the middle. The entire water area is about 24,000 feet, with a depth of six feet in the dike and sixteen feet in the centre of the pond. The dike and pond are simply excavated out of the earth, and are neither bricked nor cemented. They were simply made to carry away surplus condensed water, which runs into the pond at about 110° Fahr. The temperature of the pond just where the water runs in is about 90°, and in the coolest part 76° Fahr. Three hundred carp about five inches in length were introduced seven years ago, and now the young can be seen all the year round. Fish weighing four to five pounds are quite common, and one hundred pounds may easily be taken in an hour. Gold-fish also thrive excellently in the same water. It appears that the fish like best to be where the water is warmest, especially the younger ones. The locality referred to is near Bonn, on the Rhine.—2 *A*, *April* 5, 271.

SHAD IN THE MISSISSIPPI.

Ex-Governor Hebért, of Louisiana, announces in the papers of his state the receipt, in the month of March, 1876, of a fine specimen of the true shad, which was caught in a dip-net near his house. This, it may be presumed, is one of the many that have been planted in the Mississippi by the United States Fish Commission.

RENEWED ATTEMPT TO SEND SALMON EGGS TO NEW ZEALAND.

A very interesting experiment has lately been entered upon in Scotland, in the form of a renewal of the attempt to send salmon eggs to New Zealand for the purpose of stocking the waters of the antipodes. This was done principally under the direction of Mr. Frank Buckland, the well-known pisciculturist. For this purpose the salmon were taken in seines, and the ripe fish selected for the experiment. The process of impregnation consisted in dropping the milt from the male fish into a vessel containing a small quantity of water, and then stripping the eggs into the same receptacle, Mr. Buckland's experience teaching him that this is better than to place the eggs in the water first, where there is no milt. He also advises allowing the eggs to remain quietly in this condition for a considerable time before washing off.

The gathering of the eggs took place on the property of Mr. G. C. Home Drummond, of Blair-Drummond Castle, nearly opposite Inverardoch House. The eggs were then carried to Glasgow to be packed. They were placed in boxes holding a cubic foot each, stratified in layers between moss; and these were placed in a large ice-box, constructed expressly for the purpose, on board the ship. The ice-box measured thirteen feet in length by twelve in width, and eight in height. In packing, ice was first arranged along the bottom, two feet thick. Upon this was deposited a square, consisting of twenty-five salmon boxes, with four in addition at the corners. Upon these boxes was put a stratum of ice two feet thick, and upon this another layer of boxes of eggs, and ice again on the top of these. All around the sides of the ice-house slabs of ice two feet six inches thick were placed, so that the eggs were surrounded by blocks of ice, the minimum thickness being two feet. Ice was also packed in the interspaces between all the boxes, precautions being taken that they should not get loose. All around the ice-house was built another ice-box, leaving an interspace of eighteen inches. This was filled tight with sawdust, to keep the temperature as equal as possible. In addition to the salmon eggs, some thousands of eggs of trout were also forwarded.—2 *A*, *January* 16, 1875, 48.

SALMON IN THE ANTIPODES.

The actual existence of mature salmon at the antipodes, from the eggs transported thither, is not fully proved, although Mr. Youl is of the opinion that the evidence is clear as to the success in New Zealand, as he publishes in the London *Field* a paragraph from an Otago daily paper stating that a large salmon had been taken in one of the northern streams, its eyes having been picked out by a sea-gull. This was captured by parties familiar with the Scottish salmon, and who felt sure of its character. The fish weighed about forty pounds.

Mr. Youl also publishes a letter received by the Acclimatization Society of Otago, which had accompanying it a photograph of a salmon-trout taken in Otago Harbor, weighing ten pounds eight ounces, and measuring twenty-six inches in length. It is an interesting fact in this connection that in 1870 there were one hundred and forty eggs of salmon-trout brought from Tasmania, from which one hundred young fish were liberated in the beginning of 1871, from a stream about thirty miles north of Dunedin. Within the last eighteen months upward of a dozen sea-trout, weighing from two to five pounds, have been taken, in addition to the one first referred to, so that we have here at least fourteen fish out of one hundred already captured, with a strong probability that a good many more escaped the perils of infancy, and attained maturity. This percentage of fourteen in a hundred is much larger than fish-culturists have dared to claim as the result of their efforts, and if it be any thing like an average, it furnishes a great encouragement to the efforts now in progress in America and elsewhere to introduce and multiply useful food fishes.—19 *A*, *February* 19, 196.

SALMON EGGS IN SOUTH AFRICA.

Among the efforts to acclimatize the salmonidæ in the southern hemisphere may be mentioned the transmission of eggs of the trout to South Africa. Mr. Campbell Jobson, about Christmas, 1875, obtained from Frank Buckland some eggs for the government of the Cape Colony, and succeeded in transporting a large proportion in good condition to Cape Town. Here they were placed in charge of Dr. Hidding, who had provided himself with the necessary apparatus; but, though a number of the fish were hatched, only one survived. It was thought that a more extended time for preparation would have given a more satisfactory result.—2 *A*, *June* 17, 440.

CAPTURE OF SALMON IN THE CONNECTICUT RIVER.

We are happy to announce the capture in a gill-net at Middle Haddam, in the Connecticut River, on the 24th of June last, of a superb salmon weighing eighteen and a half pounds. It is well known that the Connecticut, up to the early portion of the present century, abounded in salmon—to such an extent, indeed, that the usual plea was made by paupers and apprentices that they should not be obliged to eat them more than two or three times in a week. For many years, however, the fish has been entirely exterminated there, and there was no hope for a restoration except as the result of the action of the State Fish Commissioners in introducing the young into various parts of the stream. Judging from the size, it is probable that the fish now taken is one of the 30,000 fry placed in Williams River, in Vermont, in 1870, and it is to be hoped that more of this crop, as well as of the succeeding, will make their appearance. Several millions of young fish have been placed in the Connecticut, most of which, however, will not be due for a year or two. The specimen in question was sold for ten dollars in the Hartford market.

ARTIFICIAL CULTURE OF PEARL-OYSTERS.

At a recent meeting of the Society of Acclimatization of Paris, a medal of the first class was awarded to Lieutenant Mariot for having established at the island of Arutna, one of the Paumotou islands of the Oceanic group, artificial inclosures for the cultivation of pearl-oysters, the result of the experiments so far made promising that the enterprise would be successful.—10 *B*, *May*, 1876.

REPRODUCTION OF THE OYSTER.

Gerbe, who has given considerable attention to such subjects, informs us that oysters are capable of reproduction during their first year of growth, much before they have attained a marketable size. He has even seen oysters of less than an inch in diameter with the sexual conditions mature. It would therefore appear that the multiplication of this important bivalve does not require the presence, in a park, of full-grown oysters, since those of a much smaller size have been proved to answer the purpose.—3 *B*, *March* 2, 307.

FATTENING OF OYSTERS.

Professor Fraser, in a communication to the Academy of Natural Sciences, in speaking on the general subject of Dialysis, suggested its application to the fattening of oysters, remarking that oysters brought to the large markets are generally immersed for a short time in fresher water than that from which they were taken, resulting in an increase of size or plumpness. This, however, only lasts for a few days. At the end of this time the oysters become lean again, having lost the plump appearance. Dr. Fraser remarks that, although sometimes corn meal or other substances are placed upon the oysters during this operation, it can have no material effect in increasing the amount of the flesh, but that the increase in size is due entirely to the absorption of moisture. The tissues of oysters when first taken are saturated with the ocean brine, and when removed to fresh water, or that which is less salt, the external liquid passes inward more rapidly than the more saline and denser elements within can escape; the effect being simply to cause the oyster to swell, with no increase of its virtues. When the water in which the oyster is immersed is too fresh it loses its flavor. Professor Fraser suggests that by immersing the oysters for some days in concentrated brine, and then removing them to ocean water, the plumpness would be gained without the sacrifice of the saltness which is so agreeable to the epicure. A simple method of ascertaining whether the oysters increase in flesh or not would be to take one hundred or more from a given locality on the sea-coast, and, drying them at 220° Fahrenheit, ascertain their average weight; after which repeat the process for the same number of like oysters after being gathered and treated in the usual manner.—2 *D*, 442.

K. DOMESTIC AND HOUSEHOLD ECONOMY.

THE CONSTRUCTION OF WINDING STAIRCASES.

In Major Elliott's Report on European Lighthouses, he notes that in several cases the stairs are circular, and apparently self-supporting, one end only being built into the wall, as in the Treasury at Washington. This method of stair-building is, he observes, universal in Europe, both in private and public buildings. The most recent lighthouse towers of the American system are constructed with conical interior walls and iron staircases winding around the interior of the cone. European towers are generally constructed with an exterior conical, and an interior cylindrical wall, leaving an unnecessarily large unused space between the two. The amount of masonry in the American system is the same as in the European, and is better calculated to resist the overturning effect of the severest gales.—*Elliott's European Lighthouse System*, p. 25.

SELF-CLOSING HINGE FOR STORM-DOORS, DOUBLE DOORS, ETC.

A very ingenious self-acting hinge for storm-doors, double doors, etc., opening in one or both directions, has been devised by Koch, of Berlin. It is said to allow the door to move easily and noiselessly, and also to be fixed at an angle of a little more than ninety degrees, if desired, without any fastening. A full description, however, can only be given with the aid of a figure. The door moves on a pivot at the top and bottom, the rear end at the bottom resting in a shoe, to which it is firmly screwed, and which has the pivot attached to it beneath, and also a small wheel a little in front of the pivot. As the door is opened this small wheel moves upon an arm of a lever, the other arm of which is in contact with the end of an almost circular horizontal spring, which carries the door back to its normal position, as soon as it is released, the power being greatest just when the door is released, and diminishing until it is completely closed. The spring, lever, etc., are inclosed in a cast-iron box, covered with a brass plate, screwed to it, countersunk to the level of the floor. The upper socket, set in the casing of the door, is attached to a plate, which has a slit and set screw, so that it can be moved forward or backward slightly, and thus be adjusted to any inaccuracies in hanging the door. The upper pivot is let into the top of the door and rests upon one end of a lever, also let into the top of the door, and is forced up into the socket by a screw acting on the other end of the lever, nearer the front of the door, thus rendering it easy to hang or remove.—5 *C*, XLVI., 366.

MYSTERIOUS CLOCKS.

Robert, of Paris, has succeeded in carrying out practically an old suggestion for the construction of clocks apparently without works, by employing aluminium for the light parts, and platinum for a movable weight. The clocks, as made by him, seem to consist simply of a glass face, supplied with two hands, to which counterpoised weights are attached. These latter, however, contain diminutive works, which vary the position of a piece of platinum in such a way that its weight, in connection with that of the hands themselves, causes them to turn.—6 *C*, *June* 3, 1875, 216.

PREVENTION OF THE CRACKING OFF OF GLUE.

The cracking of glue, which frequently occurs when glued objects become very dry or are subjected to the heat of a stove, it is said, may be prevented by the addition of chloride of calcium to the glue, which prevents its drying so completely as to become brittle. Glue thus treated will adhere to glass, metals, etc., and can be employed for affixing labels to bottles.—5 *C*, XXXVIII., 304.

NEW LIFE-SAVING DEVICE.

The Paris Maritime Exhibition afforded the opportunity for the experimental demonstration of the great value of the "Gay Safety Mattress," an indorsement in which all accounts agree. The device, which is both a mattress and, in case of necessity, a life-preserver, is formed of two rows of blocks made of cork-cuttings, lightly compressed by machinery within a water-proof case, and the whole covered with canvas. It forms ordinarily a mattress, which is intended to be placed in every cot or berth, and makes a bed which is said to be very elastic and easy to lie upon. Its weight is about six and a half pounds, and it is constructed in such a manner that it can be quickly put about the person, forming then a double belt, attached in such a way that it can not possibly be displaced. The whole process of rising from the mattress, attaching it to the person, and entering the water was performed at the Exhibition within three quarters of a minute. The limbs are not confined, nor the motions of swimming interfered with. It places within reach of every passenger an efficient and reliable life-preserver in any sudden emergency, and appears to be the most sensible and practical device of this kind as yet invented.

ELECTRICAL ILLUMINATION OF FACTORIES.

In spite of the recent improvements in magneto-electric machines, especially that of Gramme, electrical illumination in factories has not displaced that by oil or gas to any extent. The Gramme machine has, however, been introduced, with satisfactory results, into an establishment at Mülhausen. The room illuminated is 196 feet by 98 feet. Four lamps, on Serrin's plan, properly distributed, are employed, each run by a separate magneto-electric machine requiring about two-thirds horse-power to work it. The carbon points need changing every three hours. The cost for the four lamps per hour is about twenty cents. During two months of use no diminution of intensity has been noticed, and the illumination afforded has been steady and superior in brilliancy to that from any other source. The magneto-electric machines cost about $300 apiece, or the four arranged, complete, about $1600. Laboulaye gives the following table of the comparative cost of this and other methods of illumination:

Source of light.	Consumption per hour for 1-stearin candle-light.	Cost per hour for a 700-stearin candle-light.
Electricity, by magneto-electric machine.		0.10 to 0.20 francs
Electricity, by galvanic battery..........		3.00 to 5.00 "
Coal-gas..............................	15 litres	3.20 "
Light petroleum........................	4.52 grammes	3.85 "
Rape-seed oil..........................	5.18 "	6.10 "
Tallow candles.........................	10.55 "	12.60 "
Stearin candles........................	10.40 "	26.20 "
Wax candles............................	8.26 "	32.40 "

Efforts to distribute the current from a single machine to several lamps have not proved practically successful, by reason of the great increase in the cost of illumination, so that Gramme has been led to construct small machines of fifty candle-power. While these operate very well, the light, however, is not perfectly steady, and the machines found best adapted to practical purposes are those that yield a one hundred candle-light.—6 *C*, *June* 3, 1875, 215.

A NEW INCANDESCENT LIGHT.

Hannecker, taking advantage of the properties of incandescence, has obtained a lamp of extraordinary brilliancy by directing the flame of a spirit-lamp of special construction and fed by a current of oxygen against a cylinder composed of silicate of lime, magnesia, and olivine, which latter is a natural silicate of magnesia. The cylinder composed of these earths is compressed by hydraulic pressure, in a manner not very different from the method employed for forming the cylinders used in the Drummond light.—3 *B*, XXXV., 247.

AUTOMATIC HYDRAULIC BLOWER FOR GAS-MACHINES.

A recent invention designed to substitute the meter wheel and weight (or coiled spring), water-wheel, and other devices for driving air gas-machines, consists of the well-known mechanical device known as the tromb, or water air-pump, in connection with an automatic cut-off valve operated by the rise and fall of the gasometer dome. The whole machine is self-contained, and is completely automatic in its action.

COMBINED STREET-LAMP AND FIRE-HYDRANT.

An invention of this description, which is now attracting attention from the heads of fire-departments, is designed to diminish the number of obstructions to the highway, and to afford light in finding the hydrants and operating the engine. The valve is of peculiar construction, operating with a quarter turn of the spanner, and affording unimpeded water-way.

NEW SAFETY-LANTERN.

In Paris, night-watchers of factories and warehouses containing highly combustible material are supplied, for safety, with a peculiar lantern. A piece of phosphorus about the size of a pea is introduced into a glass flask, which is then one third filled with boiling olive-oil and closed air-tight with a cork. When light is desired the cork is simply removed for an instant to admit the air, and a clear light is emitted from the empty space in the flask. The intensity of the light when it diminishes may be renewed by admitting air again. A lantern thus prepared, it is said, may be used continuously for about six months without the least trouble.—15 *C*, XXIII., 368.

THE CHANDOR LIGHT.

At a recent gathering in Edinburgh, Professor Archer drew attention to a new invention—the Chandor light. The apparatus is, in outward appearance, a small tube three or four inches long, having at one end a revolving button, which turns a screw, and at the other a minute angular point of metal, which also revolves, passing over a little orifice in the closed head of the tube. A continuous tube, formed of a delicate strip of solidified collodion, with a ridge of hardened phosphorus on one of its sides, is slipped into the tube, and, once in position, can be moved upward by the screw. By the same action which presses the upper end of the fuse against the opening of the top, the metal point is turned against the phosphorus, and a small portion of the collodion is thereupon ignited. When the apparatus is affixed to a gas-burner, only a very transient flash is needed for the purpose of ignition, and not more than a seventieth part of the collodion fuse is consumed in the operation. When, however, the wick of a lamp has to be lighted by the same means, a larger proportion of the fuse, the thirty-second part in fact, is burned. The apparatus is either portable or adapted to the uses indicated. If a lamp goes out, it can be instantly relighted by a turn of the screw, instead of by opening the case, removing the chimney, and striking a lucifer match, thus affording a great advantage in cases where quantities of combustible material are lying about.—*The Builder*, *Feb.* 13, 1875, 149.

LAMP FOR BURNING NITRIC OXIDE GAS.

The brilliancy of the light produced by the combustion of nitric oxide gas, after mixture with a few drops of sulphide of carbon, has been known for some time, and its application to photographic purposes suggested; but it is not until recently that Messrs. Delachanal & Mermet have constructed an apparatus by which it can be made practically available.

They use a lamp made of a pint bottle, having two openings through the cork, and filled with fragments of some porous substance, as sponge, coke, or pumice, for the purpose of imbibing the sulphide of carbon. A tube, reaching within one fourth of an inch of the bottom, passes through one opening in the cork, and a larger one through the other opening. This is about eight inches long, and may be of glass or metal, and is closely packed around with iron-scale. The object, like that of the gauze in the safety-lamp, is to prevent the return of the flame into the bottle, and its consequent explosion. The nitric oxide gas is passed into the bottle through the first-mentioned tube, and the gaseous mixture is conducted by a rubber tube to a kind of Bunsen burner, the air-holes of which are closed, and which is furnished with a small conical valve to regulate the flow of gas. This burner is also filled with iron-scale. The nitric oxide gas is produced in the cold by Sainte-Claire Deville's method, by the action of a mixture of nitric and sulphuric acids upon metallic iron. With an apparatus of quite moderate dimensions a dazzling flame, not less than ten inches in height, can be obtained, abundantly sufficient for the purposes of photographic work. It has been estimated that the photographic power of the lamp is superior to that of magnesium, is twice as great as that of the oxyhydrogen light, and three times as great as that of the electric light. Furthermore, the flame is absolutely steady, and there is no danger of its sudden extinction, as with magnesium; and the eye can sustain its brilliance without being affected. Its cost is much less than that of either of the other lights.—1 *D*, *December*, 1874, 381.

GLYCERINE FOR ILLUMINATION AND HEATING.

Godeffroy, of Vienna, found that chemically pure glycerine (sp. gr. 1.2609), when heated to 302°, burned quietly with a blue, non-luminous flame, without the least odor and without leaving any residue, and also that glycerine of low specific gravity, if not too dilute, may be burned by means of a wick or cotton immersed in it, in an open porcelain capsule. Schering has recently communicated the fact that it can be burned in any lamp in which the flame is immediately above the level of the liquid (such as the Berzelius lamp), its thick consistency preventing its giving a constant flame with a higher wick. Since its flame is but slightly colored, like that of alcohol, and since it is a much better solvent for salts, he found it preferable for the production of different colored flames; and he suggests the importance of further experiments upon the adaptation of it to illuminating purposes by mixing it with other substances rich in carbon, and also upon its heating power. Its cheapness and freedom from danger, owing to its comparative non-volatility, would render its use for the above purposes desirable.—6 *C*, 1875, 38.

ILLUMINATING-GAS FROM BONES.

As an illustration of an ingenious utilization of a waste product, the River Platte Meat Preserving Company's works in South America afford an example. Here the bones of the cattle, the flesh of which goes to fill the pots of "fleisch extract," are made to yield the illuminating-gas by which the company's factory is lighted. The works are very extensive, and some two hundred burners are supplied from these novel gas-works.—3 *A*, VI., 323.

GAS FROM CORK-WASTE.

At Bordeaux some experiments in manufacturing illuminating-gas from cork are reported to have proved quite successful. The town of Nérac, in the neighborhood, is to be lighted by it. It is obtained by distilling cork-waste, cuttings, etc., in a closed vessel, and the gas is said to be much whiter and more brilliant, as well as of heavier gravity, and cheaper than that from coal.—3 *A*, VI., 426.

BURNING-GAS FROM WOOD AND PETROLEUM.

The process of Messrs. Date & Eichbaum for making illuminating-gas is sufficiently novel and interesting to warrant the following description of the system lately introduced into the town of Ingersoll, Ontario. The retort benches (threes) here in use have some differences from the arrangement usual for coal-gas. The upper retort is provided with an inner or interior retort of cast iron, into which a regulated supply of crude petroleum is fed by an air-compressing device. The operator having thus perfect control of the amount of oil introduced, a gas of any desired candle-power can be made. The charging of the retorts and the operations involved in the process are as follows: One of the lower retorts is charged with one hundred and fifty pounds of ordinary cord-wood, and as soon as gas begins to be evolved—which is almost instantly—by means of suitably arranged pipes and valves, the wood-gas is thrown into the upper retort, in which it comes in contact with the heavy vapors evolved from the petroleum. The two gases thus commingled are then passed over a lengthened heated surface, the resultant product being a fixed or permanent gas of any desired illuminating power, leaving little or no residuum. The charcoal resulting from the process is declared to more than pay for the wood employed.—17 *D*, XX., 32.

SULPHUR IN COAL-GAS.

To estimate rapidly the amount of this impurity existing in illuminating-gas, Mr. Vernon Harcourt proposes to pass the gas through a flask filled with small pebbles, kept at a low red-heat, by which the sulphur present as bisulphide of carbon is decomposed into sulphuretted hydrogen; a known volume of the gas is then passed through a solution containing a lead salt of given strength, and the depth of coloration produced is compared with a standard set of colors, by which the percentage of sulphur is obtained.—*Proceedings British Association*, 1875.

ILLUMINATING-GAS FROM NIGHT-SOIL AND DEAD ANIMALS.

As the conversion of refuse animal matter into illuminants has often been suggested as a practical method of solving a troublesome sanitary problem, it is of interest to record the experience of Professor Troschel, director of the gas-works at Breslau, in Prussia, with an improved process of this nature lately invented by A. Sinderman. The Sinderman system, having been favorably reported upon by a committee selected by the city authorities, was introduced upon a working scale, and subjected to a careful investigation as to the quality of gas produced and its cost, and with the following results: The quantity of gas produced from a given weight of material was found to be considerably less than from the same weight of coal, so much so that, for the production of equal quantities, the new works would demand about twice the capacity of the old system with coal. The expense of the new process was found to be, contrary to all expectation, about double that of the old system. The removal and condensation of the enormous percentage of water contained in the animal refuse was found to be a source of great practical inconvenience, involving the use of an enormous cooling apparatus. One of the chief economical features of the coal system, namely, the production of coke, which not only suffices to run the works, but to return an income from the sale of the surplus, is wanting in the new process, for the operation of which the fuel must be bought. But perhaps the gravest objection to the new system lies in the fact that the refuse materials employed contain large quantities of nitrogen, sulphur, and phosphorus, and their compounds enter the gas produced as ammonia, sulphuretted hydrogen, and phosphuretted hydrogen in such unusual quantities as compared with the old system that their removal, which is absolutely necessary, demands mechanical arrangements of so complex a character as to become quite impracticable of successful operation upon a large scale. For the reasons specified, the process has doubtless been abandoned. The results of this trial, though unfavorable, are both interesting and valuable, as demonstrating the existence of grave and perhaps insuperable difficulties in the way of the utilization of such refuse matters as illuminants. There is still great room for improvements in the methods for their conversion into fertilizers.

WALKING-CANE CONTAINING A CANDLE.

A very simple walking-cane, with a candle inclosed, which might be convenient for use in dark passages, or even for reading in railroad-cars, has been introduced by a German firm. The top portion consists of a hollow cylinder screwed on, and containing a spring to press upward, as fast as consumed, a candle placed in it. It is closed by a screw cap, which forms a convenient top.—12 *C*, X., 1875, 2.

A REFLECTING-PLATE FOR OPEN GRATE FIRES.

A recent novelty among adjuncts to stoves and fire-places consists in the employment of a bright nickel-plated sheet of metal, suspended over the fire, and adjusted in proper position by a crank, the rod of which passes through the side of the stove or fire-place. While the fire is being kindled, the plate is turned toward the front to protect it from being smoked, but when the fire is fairly burning, the plate is turned back at an angle of forty-five degrees, as indicated by the wheel on the side of the stove. The result is described about as follows: The reflection from the bright metallic surface produces the effect of a double fire, and adds greatly to its cheerfulness. In addition to this, it is claimed that the large amount of heat thus reflected by the plate is, to a great extent, a clear gain, and that the effect of its employment is readily perceived in increased warmth at quite a distance from its source. Furthermore, it is claimed that the rush of air usually passing up the chimney of an open stove or grate, and which makes this excellent form of heating apparatus so expensive in rapid consumption of fuel, is checked and thrown down on the fuel, producing surface combustion, while the draught at the base may be shut off, giving a clear, bright fire, without wasteful consumption of coal.—*Iron Age, September* 30.

METHOD OF COOLING THE AIR.

MM. Nezereaux and Garlandal have lately devised a process of cooling and at the same time purifying the air introduced into dwellings for purposes of ventilation. It consists of a fan caused to revolve rapidly, by means of which the air is forced into a closed box, and made to pass through a horizontal diaphragm with holes, over which a very thin layer of water is continually flowing. The air, as it passes through this thin film of water from below, is deprived of its organic particles, which remain in solution in the water, which is continually dripping down into the lower chamber and drawn off, the air itself passing up and out through a pipe in any desired direction.—13 *B*, *Dec.* 18, 34.

IMPROVEMENT IN FIRE-PLACES.

Forestier describes an improvement in the ordinary fireplace, in which by contracting the smoke-flue for some distance above the fire-place, and by introducing side flues for the admission of fresh air, he is, he states, able to effect a very material economy in the consumption of coal; the fireplace as built by him, with an open basket grate, is superior to any of those described by Morian, Peclet, Grouvelle, and Clement. He finds that ordinary chimneys, producing the same result as attained in his own, consume four times the quantity of fuel; and the comparison with even the most improved chimneys is always decidedly in his favor.—*Memoirs Academy of Sciences, Toulouse*, 1875, 233.

CHEAP SOAP FOR ORDINARY ARTICLES AND WOOLEN FACTORIES.

Mayr recommends the following process for preparing a very cheap soap. First procure from a soap-boiler the spent lye or salt lye, either in a fluid or gelatinized condition, and preserve it in well-covered vessels until required. Prepare a soda lye of 22° Baumé, by heating in a boiler 100 pounds of calcined soda in about 52 gallons of water until it is dissolved. Add to this gradually 60 pounds of fresh, unslaked lime, stir the mixture well, and transfer the whole of it to a tub of sufficient size, and allow it to stand for about 12 hours, that the lime may settle. Then carefully dip out the lye from the lime into the kettle again, and boil until it indicates 22° Baumé. After cooling, transfer to a suitable vessel, and cover tightly. Then prepare a potash lye of 10° Baumé, by stirring potash into hot water, until the required strength is reached. As an experiment, boil 25 pounds of cocoa-oil with 30 pounds of potash lye of 10° Baumé, and add gradually, when not boiling too vigorously, 30 to 40 pounds of soda lye of 22° Baumé. After the combination of the oil and lye, and the mass has assumed the appearance of a brown glue, and is thready, add, with vigorous stirring, 159 pounds of spent lye of not over 16° Baumé, but diluted to this strength, if necessary, with lime-water. Boil the mass for half an hour, and allow the fire to die down. It will appear as fluid as water, and very unlike soap, but a sample, if allowed to cool perfectly on a board, or in a porcelain dish, will harden. The principal point at this stage is to transfer the mass to a tub, and allow it to cool, and on the following day to transfer it again to the boiler without the addition of any liquid, and after boiling it for an hour, samples will yield elastic threads indicative of increasing consistency. Then add common salt gradually, until a cooled sample feels dry upon the hand. Allow the fire to slacken, and ladle the mass into forms, which can be taken apart when the soap becomes hard. The advantage of this process is increased by repeated warming and cooling of the mass, as the proper consistency is thus hastened, and the quantity of soap increased. Cocoa-soap shavings may also be employed according to the fat they contain. If the spent lye is old, and has been exposed to the air, dilute 12 pounds of potash lye, of 22° Baumé, with lime-water to 10°, and boil it with the 25 pounds of cocoa-oil. The addition of a few pounds of crude palm-oil will impart to this soap a color similar to that of tallow soap.—26 *C*, II., 1876, 14.

CLOTH OF FEATHERS FOR LADIES' CLOAKS, ETC.

The following are the essential features of a process, recently patented, for the manufacture of cloth, suitable for ladies' cloaks and all kinds of garments, from feathers, principally of water-fowls. As the down only can be employed, the material is assorted, according to its specific gravity, by a fanning-machine. Then, after being soaked in water containing Marseilles soap, and pressed out in a square box by aid of a screw, and separated again, and partially dried by means of the fan, it is oiled, and passed three times through the fanning-machine. A fleece of wool, formed on the usual carding-machine, is then covered loosely with four times its weight of the feathers, and these by another layer of wool. The rove is then formed in the usual way, provision being made to prevent two threads from uniting. In spinning a large hand machine is employed, instead of a self-actor. The weaving is accomplished in the usual way, except that, as a rule, warp of combed-wool yarn is preferred, although, according to the material, it may be of carded yarn, or even of carded yarn and feathers. The cloth is oiled, and fulled as usual, with care to dry after fulling. In dyeing a very large vat must be used, that the whole breadth of the piece may be immersed at a time. It is finally beaten and brushed to remove any feathers not fully incorporated with the wool, and a gloss is imparted to it by steaming.—23 *C, Jan.* 1, 1876, 4.

COOKING MEAT BY COLD.

The generally accepted theory of the cooking of meat relates to the application of heat; but quite recently Dr. Sawiczevosky has called attention to the fact that almost precisely the same chemical and physical changes can be accomplished by the exposure of animal flesh to extreme cold. Indeed, the sensation experienced by touching freezing mercury is very much that of a severe burn. The experimenter referred to proposes to apply his method to the preservation of meats, first by subjecting them to a temperature of 33° Fahr. below zero, and then sealing them up hermetically in tin vessels. Animal substances, kept for a long time in these boxes, on examination proved to be extremely palatable, and, being partially cooked, required but a little additional heat to prepare them for the table.

The German government has lately been prosecuting investigations into this process as a means of preparing military and naval supplies, a large quantity suitably sealed being placed on board some vessels undertaking a long voyage, with a view of determining more definitely its availability for the purpose referred to. An establishment in Hungary is now engaged in the preparation of meats by this method on an extensive scale.—12 *B*, *April* 1, 1876, 286.

ANTISEPTIC ACTION OF SALICYLIC ACID.

In further continuation of his experimental trials of this substance, Dr. C. Neubauer affirms that salicylic acid will be of great value in the preservation of wines, but that it is adapted rather to prevent than to correct or cure morbid changes that have taken place therein.—4 *B*, *Sept.*, 1876.

PRODUCTION OF MADEIRA WINE.

It is well known that for some years past Madeira wine has been almost unknown in the trade, on account of the extinction of the crop of the island consequent upon a long series of bad vintages. The old vineyards were rooted up, and new ones planted; but of course a long time would have to elapse before any great yield could be expected, and those having in their possession genuine Madeira held it as a great prize. The least period of production extended from 1853 to 1857; and from 1860 to 1862 but 500 pipes were produced. At present the production has risen to an average of 10,000 or 12,000 pipes, which is about one third that of former years. It is not thought, however, that the quantity will ever much exceed this, since a great deal of the island which formerly was planted with vineyards is now used for corn and other crops, which are said to pay the proprietors better than wine.—17 *A*, XXI., 117.

CLEANING SILVER-WARE, ETC., WITH POTATO-WATER.

Silver and plated articles should be placed about ten minutes in the hot water in which potatoes have been boiled (with salt), and then be rubbed with a woolen rag, and rinsed in pure water, when the articles will not only be free from tarnish, but perfectly bright. Potato-water that has become sour by standing several days answers still better, and is also excellent for cleaning articles of steel and glass water-bottles.—5 *C*, *March*, IV., 32.

SUBSTITUTE FOR PERSIAN INSECT-POWDER.

The wild rosemary (*Ledum palustre*) has been suggested as a substitute for Persian insect-powder. When dried as well as fresh it is destructive to lice, bugs, fleas, moths, etc. The tincture prepared from it is also a remedy for the bites of gnats, and insects generally; not only relieving the itching in a short time, but also the pain when applied to a wound. The tincture repels gnats when mixed with glycerine and rubbed upon the skin. It seems to deserve notice on account of these properties, and its possible substitution for the more expensive and frequently adulterated Persian insect-powder. It is most effective when fresh and in bloom, and should be gathered in the latter condition.—5 *C*, 72.

DETECTION OF OLEOMARGARINE IN BUTTER.

According to Mr. Horsley, it is not difficult to determine by chemical tests the presence of oleomargarine, or artificial butter, as an adulteration in genuine butter. He remarks that fresh butter is completely soluble in methylated ether of specific gravity 0.730 at a temperature of 65°. If methylated alcohol, 63° above proof, be added to this, and well shaken, all the lard, beef, mutton, or tallow fats that may have been mingled with the butter will be precipitated. Care, however, is to be taken not to mistake the crystallization of butter out of the ethereal solution, at a lower temperature than 65°, for the fats precipitated by the alcohol. The butter, besides, being so much lighter, occupies the upper layer, is different in character, and is easily remelted by the application of the warm hand for a minute or two.—17 *A*, VI., 106.

PRESERVATIVE ACTION OF SALICYLIC ACID.

Messrs. Menetti and Musa find that salicylic acid is very serviceable in the preservation of milk when introduced in the proportion of one part in ten thousand, especially at a temperature from 55° to 60° Fahr., as it will retard coagulation for several days. It may also be used for moistening cloths in which butter is packed for shipment for distant markets. It also answers a good purpose in the preservation of cream, but is useless when applied to cheese. They think, however, that in view of the greater cheapness of boracic acid, the latter substance is preferable.—4 *B*, *Aug.*, 1876, 771.

SOLIDIFIED MILK.

A series of tests of the excellence of the Hooker process of condensing milk was lately made before several of the English technical societies. There was exhibited at the rooms of one of these—the London Society of Arts—a mass of condensed milk weighing about one hundred-weight, which had been exposed to the action of the atmosphere for four years and three months, with so little deterioration of quality that it afforded within a few minutes, by churning, an excellent quality of butter.

ACTION OF COLD ON MILK.

Tisserand has lately been prosecuting some investigations in regard to the action of cold upon milk and its derivatives, as compared with the influence of heat, and has already deduced some important conclusions that will be of service to those engaged in the manufacture of butter and cheese. He finds that on submitting the milk of a cow, immediately after being drawn, to different temperatures between 32° Fahr. and 86° Centigrade, and keeping it from twenty-four to thirty-six hours at the same temperature, the following results appeared: First, the separation of the cream is rapid in proportion as the temperature to which the milk is exposed approaches to 32°; second, the volume of the cream obtained is larger when the milk has been submitted to a greater degree of cold; third, the yield in butter is also more considerable when the milk has been exposed to a low temperature; fourth, the skimmed milk, butter, and cheese are improved in quality in the latter case.

The explanation of these phenomena Tisserand thinks is closely connected with the observations of Pasteur in regard to the origin of ferments, and the alterations which are produced in the media into which they are introduced. He suggests that this decided cooling prevents the evolution of the living organisms composing the ferment, and the power of producing alterations by their action, the influence of cold in this respect being quite similar to that which occurs in the manufacture of the Vienna beer by ice, which is so remarkable in its qualities.

There is still, however, a wide field of research open, which Tisserand thinks should be investigated. However this may be, he states that the preceding facts show how erroneous are the views which have prevailed in France on the subject of the manufacture of butter, namely, that the cream must be kept at a temperature of 55° to 56°, and not go below this. On the contrary, he insists that the two cardinal requisites for the proper manufacture, especially of butter, are perfect cleanliness of the vessels used, etc., and the employment of a low degree of temperature. There has been a tendency in France within the last few years toward the use of lower temperatures than were formerly considered necessary; but even these, according to Tisserand, are not sufficiently low.—1 *B*, *March* 5, 1876, 349.

COOKING LEGUMINOUS VEGETABLES.

The lime salts in well-water frequently prevent the thorough cooking of leguminous vegetables, especially of pease and lentils, but the employment of rain or spring water does not in all cases produce satisfactory results. By soaking them overnight in soft water, success is more certain, as they not only swell up, but part with an unpleasant acrid substance. For this reason the water in which they have been soaked should be poured off, and the vegetables washed and cooked with fresh water. With old vegetables success is more certain if we add to each one or two quarts of soft water in which they are to be soaked half a teaspoonful of baking-soda. They will not only be rendered softer in this way, but also more palatable and digestible. The addition of the soda to the water in which they are boiled does not answer the purpose as well, and in such case care must be taken not to add too much soda—at most only three to four times as much as will lie on the point of a knife to the quart of water.—10 *C*, *June* 1, 1876, 92.

GLYCERINE-GELATIN FOR PROTECTING PRESERVED FRUIT.

A composition of glycerine and gelatin, similar to that employed for printers' rollers, but of purer materials, is recommended for protecting preserved fruit, etc., from the action of the air and fermenting agencies. A thin layer of the fused mixture is simply poured upon the fruit and allowed to harden. It can be readily removed, and may be used again for the same purpose by melting it on a water bath.—13 *C*, *May* 1, 1875, 583.

SUBSTITUTE FOR EXTRACT OF MEAT AND PRESERVED MEAT.

Ungerer considers all the processes proposed for the extraction of meat or its preservation as liable to the objection of loss of a portion of the nutriment, or of complexity and expensiveness. He suggests, therefore, the following plan for utilizing the supply of meat in the less densely inhabited portions of the earth, by the conversion of it at little expense into a preparation which contains all the nutritious qualities of the fresh meat, and satisfies all requirements as to keeping. He dries the chopped meat at a temperature but little above 212°, under such conditions that all the water is expelled in less than half an hour, and the residue can then be converted into a fine yellowish powder, which, for convenience in packing, may be pressed into cakes or blocks.—14 *C*, CCXX., 382.

ICE-CELLARS ON BRAINARD'S PLAN.

The chief object in the plan for ice-cellars patented by Brainard is to prevent the deposition of the moisture in the air upon the walls, which injures them, and which also, by running down upon it, occasions a waste of the ice. The improvement is accomplished by placing a corrugated tin covering above the supply of ice, upon which all the moisture of the air deposits, and is then carried off by a suitable wooden gutter; the air of the cellar being thus always kept dry.—5 *C*, IV., 1875, 31.

REPAIRING LEAKY CELLAR WALLS.

The repairing of leaky cellar walls should never be delayed, since the crevices are continually widened by the water soaking through. Cement, tar, and water-glass are the best materials for the purpose, but the last two can only be used at a time when the cellar is dry, as in winter, perhaps even in September, or after drying and airing it in winter by artificial means. When nearly dry the leaky portions of the wall can readily be recognized, and should be marked with charcoal. Holes and cracks should first be filled with hydraulic cement. The marked places, when dry, should be coated three to four times with a solution of one volume of commercial water-glass in two of water, and finally, after becoming perfectly dry, with a solution of one volume of water-glass in one half a volume of water. Instead of the solutions of water-glass, tar, kept quite liquid by heating, may be laid on a number of times. If cement is to be employed, the marked portions of the wall should be cut out wedge-shaped, and carefully filled with a cement rather thickly made up with one third sand. If the cellar can not be dried, the moist places should be cut out somewhat deeper (four to six inches), and filled with cement, by placing a tube of any material, about as thick as a finger, in the middle, and packing the cement in tightly around it; and, if necessary, holding it in place with a board until it hardens, while the water escapes through the tube without exerting any pressure upon it. After twenty to thirty days the opening may be plugged up.—8 *C*, XII., 204.

EXPLOSIONS IN FLOUR-MILLS.

An explosion which took place, in 1872, in a flour-mill in Glasgow, led to an examination of the subject by Dr. S. McAdam, who, having discovered that similar ones had taken place in Scottish flour-mills on previous occasions, has presented to the Royal Scottish Society of Arts, a thorough analysis of the causes leading to these explosions. Most of the improved modern mills employ what is called an exhaust box, into which is drawn all the fine and light flour dust, thereby keeping the general air of the mill more free from the flour dust floating in the air. Within the exhaust box is, therefore, always found a very dusty atmosphere. Now when a light is introduced into an atmosphere of flour dust, the fine division of the flour so facilitates its rapid combustion that the flour is resolved into gases whose volume is much increased by the high temperature, so that a veritable explosion takes place, which explosion is most powerful when a certain volume of the gas is mingled with a larger proportion of air. In order that the explosion may be destructive, it is necessary that the dusty atmosphere be more or less closely confined within a given space. The most common cause of a spark or flame in the flour-mill is by the running of the feed off the stones, whereby the stones come down against each other, and quickly strike fire and become very hot. A very slight obstruction in the pipe is sufficient to so diminish the supply of grain as to allow the stones to come in contact with each other. Sometimes, again, a nail or a stone goes down with the feed, and causes sparks of fire to be struck off. Several occasions are recorded in which a crackling noise as of a running fire has been distinctly heard in the conduits leading from the stones to the exhaust pan. These slight explosions often blow open the fan box. If the flame passes the fan, however, and gets into the exhaust box, every thing depends upon the momentary condition of the air in the exhaust box at the time, as to whether the explosion shall end there, or the mill itself be blown up. The precautions to be taken in order to avoid all mill fire explosions consist specially in removing the exhaust box, stive rooms, smut rooms, and other receptacles of flour dust, to the outside of the mill. Still better is it if the conduits be provided with sliding or hinged valves which would close at once if an explosion occurs in any of the dust receptacles. Numerous other valuable suggestions are contained in Dr. McAdams's paper.—*Transactions of the Royal Scottish Society of Arts*, IX., 42.

TYRIAN-PURPLE INK FOR MARKING LINEN.

Von Bele gives the following method for preparing an ink for marking linen and cotton: Neutralize 75 grains of carbonate of ammonia with pure nitric acid, and triturate 45 to

60 grains of carmine with the solution. Mordant the fabric with a mixed solution of acetate of alumina and tin salt, and write upon it, when it is perfectly dry, with the ink.—18 *C*, *March* 5, 1876, 160.

INCREASING THE ADHESIVENESS OF COURT-PLASTER.

Court-plaster applied, as is usually done, by moistening it with the tongue, does not adhere well, on drying, to the unabraded skin adjoining the wound. By moistening the back of the plaster after it has been applied with glycerine, or, still better, by moistening the adhesive side of it when about to apply it with water to which one tenth of glycerine has been added, instead of with the tongue, the plaster will be kept adhesive and soft.—4 *C*, VIII., 1875, 72.

WATER-PROOFING UMBRELLAS, ETC.

Fischer, of Erfurt, suggests that, by the following treatment, umbrellas of alpaca, etc., can be rendered water-proof without impairing their color, flexibility, or durability, so that they will not become heavy with rain, and can be put away immediately after use without necessity for drying: Dissolve one part of shaved paraffin (a piece of paraffin candle will answer) in 10 to 15 parts of benzol by shaking it in a bottle. Pour the solution over the whole of the expanded umbrella rapidly in spiral lines, beginning at the top. Great care should be taken not to conduct the operation near a lamp or stove.—8 *C*, *August* 26, 1875, 312.

IMITATION OF STRAW, LEATHER, AND WICKER-WORK.

Imitations of straw, leather, wood, and wicker-work articles are produced by Löwenberg by the following process: A mould of the article to be imitated is made by pouring around it a mass consisting mainly of glycerine and glue. Into this, when firm, a liquid consisting chiefly of glue, glycerine, oil or soap, and some pigment, is poured, and before the whole of it sets the larger part is poured out again, leaving but a comparatively thin film, which constitutes the imitation when firm. Adhesion to the mould is prevented by treating it with chromic acid or acetate of iron.—6 *C*, *September* 9, 1876, 358.

L. MECHANICS AND ENGINEERING.

PRESERVATION OF WOOD.

According to Lostal, wood is rendered quite hard, and capable of resisting decay for a long time, by covering it in a large cistern with unslaked lime, and adding water from time to time until the lime is slaked, and allowing it to remain, according to the size of the pieces, until it is sufficiently penetrated by the lime-water; for that to be used in mining operations a week will suffice.—18 *C, February* 9, 1876, 95.

CARBOLIC ACID AND THE PRESERVATION OF WOOD.

The impression that a solution of carbolic acid has a preservative action on wood, founded on the assumption that tar preserves wood by reason of the carbolic acid and creosote it contains, is asserted by M. Boucherie to be entirely erroneous. Samples of different kinds of wood impregnated with one-half per cent., one per cent., and two per cent. solutions of carbolic acid, and then buried in a soil rich in humus, were found to be as completely decomposed after six years as samples that had not been so treated, while others impregnated with one and a half per cent. solution of sulphate of copper were unchanged.—28 *C*, IV., 66.

NEW PROCESS FOR THE PRESERVATION OF WOOD.

A new process for preserving wood from fire and decay has been invented by Messrs. Weatherby and Moore. It consists first in kiln-drying the wood, which deprives it of all moisture, and much of its volatile turpentine and other inflammable matters. It is then put into suitable cylinders, in which lime and water, with sulphurous acid gas, are forced into the pores of the wood under considerable pressure. The wood is removed, dried, and is then ready for use. The chemistry of the process consists in the formation of a soluble sulphate of lime by means of the sulphurous acid and the lime; this crystallizes as a bisulphite, which oxidizes and is converted into the sulphate of lime or gypsum. As this is an exceedingly insoluble salt, it is not easily removed from the pores of the wood, and not only by its presence protects it as a non-conductor of heat, but deoxidizes all matters which are likely to prove objectionable as ferments.—1 *A*, XXXI., 75.

NEW PROCESS FOR INJECTING TIMBER.

In this process, the invention of Mr. G. B. Smith, any antiseptic compound that may be preferred is applied in solution directly to the end of the green log, and by the application of hydraulic pressure is forced to enter by the natural sap channels of the wood, by which operation the sap is forced out at the other end. The necessary pressure is maintained by the use of an ordinary hydraulic pump until all the sap is expelled, and the preserving solution appears in full strength at the farther end, when the thorough saturation of the log is most effectually assured. The mechanical appliances are simple, consisting merely of a cast-iron cap, fitted tightly against a metal ring driven into one end of the log, by means of a chain, or rod, and clamp passing over the other end, and communicating directly with the pump.

IRON AND STEEL FOR BOILERS, BRIDGES, ETC.

At a meeting of the Franklin Institute, committees were appointed to investigate the subject of the strength of iron and steel, with directions to make such experimental trials as may be necessary to include materials such as are at present found in the market, and employed for the construction of boilers, bridges, and other structures of iron and steel. In pursuance of this resolution, the sum of $1000 was appropriated for the purpose of defraying the cost of the purchase and preparation of samples of iron and steel for the testing-machine.—7 *D*, *September*, 1875.

CAST STEEL FOR LOCOMOTIVE BOILERS.

According to the Society of German Railroad Engineers, the use of cast steel for locomotive boilers has not been so satisfactory as was expected.—18 *A*, XXI., 89.

BESSEMER PROCESS WITH HOT BLAST.

Heyrowsky states that during the summer of 1874, at the Bessemer works in Zeltweg, fifty to sixty charges were made simply with a hot blast of about 1200° with cast iron, the analysis of which gave 0.8 per cent. silicon, 2.23 per cent. carbon, and 2.2 per cent. manganese. After the fusion it contained 0.7 per cent. silicon, 2.3 per cent. carbon, and 1.3 per cent. manganese. The charges were very hot, and the expectation, founded on theoretical considerations, that a slightly carburetted iron could be Bessemerized with hot blast, was confirmed. A larger than usual quantity of ends of rails could also be thrown in, amounting to eighteen per cent. instead of twelve per cent., as with cold blast. Among the practical difficulties that prevented its continuous use was the decided effect upon the lining, which often became useless after two charges, instead of withstanding an average of fifteen or sixteen; and, besides, all portions in contact with the hot blast were so intensely heated that they rendered manipulation difficult, and it would require long practice to accustom the workmen to the heat. For this reason the use of the hot blast was abandoned for the present, although the results were considered favorable.—13 *C*, *July* 1, 1875, 851.

EXTENDED SERVICE OF A FURNACE.

The Emma Furnace managers have communicated to the *American Manufacturer* the extraordinary announcement that the furnace stood banked up from December 4, 1874, to July 9, 1875, without blast or draught, during a most severe winter. This is equivalent to seven months and five days, or 217 days, and during all of this time it held its fire intact without chilling or cracking. On December 4th the iron was run out, and the furnace filled wholly with Connellsville coke, every precaution being taken to have the fire remain until advisable to resume operations. It stood idle until January 9, 1875, and during this entire time not a thing was done to it, or a pound of fuel added. When opened at above date some two thirds of its coke was alive, and the furnace, after clearing away ashes, etc., was ready to resume operations. This record of the "Emma" has to our knowledge never been equaled.

REVOLVING FURNACE BARS.

Foreign technological journals find a very considerable improvement in furnace grates in an invention of M. Eloy Schmitz, who replaces the straight fire-bars ordinarily used singly or in pairs, by hollow cylindrical bars pierced with holes, and so arranged as to revolve readily. The new fire-bars rest on supports which are themselves cylindrical and hollow; they are supported lengthwise by a plate fixed beneath the door of the fire-box, and fitting into a neck made at the near end of the bar. With this construction, it is affirmed, the duties of the stoker are rendered much less important and troublesome, and a very material economy of fuel is effected. The following advantageous features are claimed for it: The layer of coal resting on the grate may be doubled in thickness, thus obviating the necessity of frequent charging and the entry of cold air into the fire-box. The interior of these hollow bars being always visible to the stoker, he is able to observe any choking of the air passages as soon as it takes place. It is only necessary for him then to give the bars a fractional turn with the winch, and a clear surface, free from slag and scale, is presented to the fuel. This is accomplished without opening the doors and admitting an excess of cold air. The rotation of the bars has the additional beneficial effect of clearing the obstructed part and throwing down into the ash-pit the ash and other non-combustible impurities, the retention of which retards combustion. The economy of fuel which is claimed for the new construction is of even more importance than the economy of labor.

AMERICAN MINING METHODS.

One of our Comstock mining engineers, lately returned from a tour of inspection through the mining districts of Germany, communicates to a California daily his conviction that there is no engineering in Germany to compare with that on the Comstock lode, and no mines in which the mechanical appliances are so ingenious and effective. He supports this assertion by a graphic description of the crude and primitive methods in vogue abroad. He remarks that in the deep mines of Bohemia the hoisting apparatus consisted merely of open tubs, and the operating machinery was so poorly constructed that he dared not venture to descend. In most of the German mines, he found that the men were compelled to walk up or down to the scene of their labors, either by going down an incline, or by using long parallel stilts, which move up and down alternately about six feet at a time. The mode of ascending and descending on these is to step from one to the other, as each ascends or descends, where a misstep would be attended with fatal consequences. His remark that in the Comstock the men went down to the lowest levels and came up in two minutes without the slightest exertion was received politely but incredulously. The character of the mining tools employed is criticised in the same uncomplimentary strain, and the assertion is made that an average day's work upon the Comstock would seem incredible to the miners of continental Europe.

STATISTICS OF STEAM.

Statisticians calculate that there are now in work some 200,000 steam-engines, with a total power of 12,000,000 horses, corresponding to the muscular strength of 100,000,000 men.

CASING FOR STEAM-PIPES, ETC.

The following composition is recommended by Dr. Springmühl for coating steam boilers, pipes, etc., by laying it on from three quarters of an inch to one and a quarter inches thick, according to the size of the object: White pipe-clay, 30 parts; fire-clay, 25 parts; powdered charcoal, 20 parts; rye-flour, 7 parts; boiled linseed-oil, 5 parts; cow's urine, 8 parts.

CASING FOR STEAM-PIPES.

The German *Journal of Woolen Manufactures* gives the following for casing steam-pipes: Mix fuller's earth, that has been used and collected in sinks for this purpose as well as to prevent the filling of streams, with fully the same quantity of coal-ashes, and add to the pasty mass as much calf's hair as it will take up. Before laying it on add one eighth its quantity of calcined gypsum, and lay it on in thin coats. If the first layer does not adhere well, unused fuller's earth may be used for it.—23 *C*, VII., 50.

ANTI-FOULING COMPOSITION.

It is said that the copper sheathing of the two royal English yachts *Alberta* and *Elfin* were in 1873, at the command of the Admiralty, painted with Jesty's patent anti-fouling composition, in order to prevent the adhesion of sea-grass and other substances. These two vessels have been again docked in Portsmouth, having in the mean time lain principally in harbor. The test of Jesty's composition was very satisfactory. All portions of the sheathing were found to be free from algæ or other substances, and remained precisely as they were at the time they were first painted, excepting some very small spots under the stern, where a green slime had formed of the thickness of a sheet of paper.—*Mitth. Oesterr. Hydrog. Bureau*, 1874, 494.

PREVENTION OF BOILER INCRUSTATIONS.

Lesueur proposes the use of metallic zinc as a preventive of boiler incrustation. Twenty kilogrammes, introduced into a boiler of 100 horse-power, is sufficient for at least three months. The zinc disappears, and whatever is deposited from the water forms no crust, but only a loose mass which can easily be washed out. The mode of action is not yet explained, but M. Lesueur supposes electrical force to be involved. A galvanic couple may be formed by the zinc with the metal of the boiler, so that a little water would be decomposed. Thus a film of hydrogen might be produced and continually renewed on the surface of the iron, preventing the adherence of any deposit.—*Ann. de Ch. et de Phys.*

APPARATINE, A NEW ANTI-INCRUSTATOR.

A new anti-incrustator has lately been introduced under the name of apparatine, which is prepared by stirring up sixteen parts of potato starch in seventy-six parts of water, and then adding eight parts of potash or soda lye, at 25° Baumé, the whole to be thoroughly mixed together. In a short time the mixture forms a thick jelly, and it is then beaten up vigorously for a time, when it forms a colorless, transparent substance, slightly alkaline to the taste, and of a strong glue-like consistency. It dries slowly in the air without decomposition, and when perfectly dry resembles horn, but is more flexible. When introduced in small quantity into steam-boilers it prevents their incrustation. It is also capable of nearly all the applications of ordinary gelatin, and is especially adapted for sizing textile goods of all kinds, imparting to them a hitherto unattained smoothness. When once applied to goods and dried it is perfectly insoluble, as three or four washings in hot water have proved to have no effect upon it. It can also be used as a thickening in calico-printing. Several of the technological journals speak of this substance as a very important addition to the resources of the dyer and manufacturer. Care must be taken to retain it in air-tight vessels until it is used, as it is not easily rendered soluble again when it has once become hard.—18 *A*, XXI., 29.

MINERAL PRODUCTS OF EUROPE FOR 1874.

The Austrian statistician Brachelli estimates the total mineral product of all the countries of Europe for 1874 to have been as follows: Platinum, 1025 kilogrammes; gold, 6900 kilogrammes; silver, 300,000 kilogrammes; pig-iron, 240,000,000 hundred-weight; copper, 600,000 hundred-weight; lead, 5,300,000 hundred-weight; zinc, 2,700,000 to 3,000,000 hundred-weight; tin, 205,000 hundred-weight; coal, 4,376,000,000 hundred-weight; salt, 95,000,000 to 100,000,000 hundred-weight; manganese, 1,616,000 hundred-weight; antimony, 5700 hundred-weight.

PRESSURE GAUGE TO REGISTER 54,000 POUNDS.

A mechanical novelty worthy of being placed on record is a mercury column pressure gauge lately completed by Thomas Shaw, of Philadelphia, for a company in that city, which is capable of registering a pressure of 54,000 pounds to the square inch. The body of this gauge was forged solid from the best Midvale steel, and bored and turned to the proper shape. The total height is six feet, that of the mercury column being four and a half feet. The area of the large plunger is six and a half inches, and of the small one three sixteenths, and the movement about one thousandth of an inch. No gauge has yet been built to register so high a range of pressure as this one.—18 *A*, XXI., 35.

INCRUSTATION OF BOILERS.

At one of the recent meetings of the French Academy, this important subject was discussed. M. Lesueur, a telegraph inspector, sent a communication to the Academy setting forth the efficacy of zinc in protecting steam-boilers from incrustation. The substance of M. Lesueur's remarks was to the effect that in many instances the action of zinc for this purpose had been found to be excellent, the deposit of scale being small in quantity, and easily removed. These statements met with considerable opposition. It was asserted that in many cases where it had been applied the zinc had failed entirely to produce any useful effect; and a number of authorities were quoted to prove that the success of the zinc or "galvanic" process was at best questionable. The opinion prevailed that in view of the vast differences in the nature of the feed-water employed in different localities, there could scarcely be any universal panacea for the evil of boiler incrustation.

AN AUTOMATIC RELIEF-VALVE FOR STEAM FIRE-ENGINES.

The damage caused by excessive flooding with water at fires frequently exceeds that by fire, and any appliance that prevents this is deserving of recognition. The Committee of Science and the Arts of the Franklin Institute lately awarded the Scott Legacy Premium and Medal to John E. Prunty, of Baltimore, for his automatic relief-valve for steam fire-engines, designed to give the pipeman full and instant control of the stream, enabling the latter to shut off instantly to prevent damage by water, to change nozzles, or to move the hose easily. The valve is applied between the pump (or hydrant) and the hose, and consists of a barrel-shaped chamber, with an auxiliary cylindrical valve-chamber parallel to this, and communicating therewith by two ports. A double beat valve in this latter chamber allows, when open, the exit of water from the main chamber through an eduction port. To the stem of this valve is attached a lever with ring-shaped termination floating freely in the main chamber. The areas of this ring and of the poppet-valves are so proportioned with respect to each other and the cut-off nozzle at the end of the hose line, that when the nozzle is open and the current unobstructed the water will pass through the main chamber to and through the hose; but any stoppage of the current by means of the cut-off nozzle, or from a wall falling on the hose, etc., allows of the instant opening of the balanced valves and the discharge of the water through the eduction port, which has a larger area than the nozzle. The water so discharged may, if desired, be returned to the suction side of the pump. Being entirely automatic at any pressure, and operating without any increase of pressure upon pump or hose line, the valve largely increases the efficiency of the engine to which it is attached.

SELF-WATERING LOCOMOTIVES.

One of the most practical improvements which is coming into very extensive use in this country is the self-supplying water-apparatus for locomotives. As the following description will show, the devices employed are at once simple and efficient: A water-trough from eight hundred to twelve hundred feet long is laid between the tracks of the railway, and as the engine passes along at a velocity of, say, twenty miles an hour over the trough, the fireman, by means of a lever, lowers one end of a pipe, and the water is scooped up, as it were, into the tender. In winter the water in the trough is prevented from freezing by means of steam-pipes. The convenience of this device is not its only meritorious feature, for, in addition to this, it saves considerable time in stoppages at watering-stations, thus permitting a more moderate rate of speed to be maintained—a practice which realizes material economy in the running of trains.—6 *D*, XXXII., 245.

STATIONARY HYDRAULIC ENGINE FOR RAILWAYS.

The application of the hydraulic power to the movement of a system of belts or bands in working stationary railroads, especially in mines, forms the subject of a memoir, by Cavallero, lately communicated to the Academy of Sciences of Turin, in which he specially discusses the methods invented by Aguido, and applied by him to several roads in Italy. The theoretical investigation of Cavallero is supplemented by a numerical application to the apparatus established on the inclined plane at Lauslebourg.—*Atti della R. Acad. della Scienza, Turin*, 1875, L., 577.

ELECTRO-CAPILLARY MOTOR.

A curious little engine, termed an electro-capillary motor, has been described by M. Lippmann. If a globule of mercury be placed in a saucer, together with a little solution of potassium dichromate, acidified with sulphuric acid, and it be touched upon the side with a point of iron, it will at once contract laterally, drawing itself away from the iron. This will break the contact; gravity will spread the globule out again, when it will again touch the iron and contract; and so on. The explanation of this phenomenon is to be found in the fact that the electric current developed on contact of the two metals changes the capillary constant of the mercury, and hence its form. This is the action which M. Lippmann has utilized in his motor. In a glass tank filled with diluted sulphuric acid are two small cylinders containing mercury. A bundle of capillary tubes, open at both ends, is placed in each cylinder, resting on the mercury, each bundle being connected above with one end of a walking-beam, to the prolongation of which is attached a connecting rod, crank, and fly-wheel. By means of a commutator on the axis of the fly-wheel, the mercury in each cylinder is alternately connected with a small battery; its capillary constant is changed, its ascent in the tubes increased, that side preponderates, and causes a semi-rotation of the fly-wheel. This sends the current to the other cylinder, which, acting similarly, completes the rotation. As many as one hundred revolutions per minute have been obtained with this engine. Conversely, on rotating the fly-wheel by hand, a galvanometer in the current indicates the production of an electric current.—3 *B*, XXXV., 5.

RAILWAY SIGNALS AND BLOCKS.

The Highland Railway of Scotland has introduced upon its road what the English journals describe as a novel and ingenious combined block and signal system, the invention of Dr. Whyte, who has devoted several years to the work of improving the mechanical arrangements for operating railway trains. The system is entirely self-acting, and its operations are performed with the agency of an electro-magnetic machine of simple construction. An engine running past, say two stations, blocks the line at the first by raising a semaphore; places an automatic check against the passing of a second engine by the ringing of an alarm-bell on the second engine itself, should it attempt to follow; announces its approach to the second station, or can be stopped by the station-master there; while on reaching that station it clears the line at the previous one of both semaphore and alarm-bell, so as to leave it free for any approaching train. The apparatus itself may be divided into two parts, one being on the engine, and the other connected with the line. Four wire brushes, each pair metallically connected, are suspended from the engine, one pair having a battery and bell in circuit, and the other a bell. A wheel descends alongside these brushes. On the line, between the rails, at such distances as may be thought requisite, or in close proximity to each station, a series of insulated metallic plates, in an air-tight box, are laid down, each plate being from five to ten feet long. By the side of each pair of plates, the ends of which are connected by wires, is placed an electro-magnet, with wires from a battery attached. The keeper of the magnet is fixed to a lever by means of a pulley, and as the engine travels past this lever is pressed upon by the wheel above mentioned, and the keeper is forced up against the poles of the magnet. Thus the semaphore arm is raised and the line effectually blocked. With the view, however, to guard against a possible inattention on the part of the driver of an engine approaching the apparatus, the box is left in such a position that should his engine pass over it while the signal is up the alarm-bell on the engine itself is instantly rung. The first engine having successfully blocked the line in the rear, proceeds to the next station or signal-post, where the line is again blocked; and by means of wires to the last box and mechanism similar to that above described, the electro-magnet at the former station is released, the semaphore lowered, and the way left clear between these two sections. Thus it is clear that each train protects its rear for the distance between each pair of plates. The line being, as it were, divided into sections, each train as it enters a section instantly blocks it so that no other train can follow until the first has proceeded without the bell being rung as a warning. Connected with this automatic electrical block system is an arrangement by which each train can announce its approach to any station, and another for giving the station-master the power to stop a train by causing the bell on the engine to ring. The brushes on the engine are the means by which this is accomplished; a powerful battery placed at one station, or smaller batteries placed in suitable positions along the line, being the agency by which the apparatus is operated. As these batteries are never in circuit except when a train works them, the waste is reduced to a minimum. The advantages claimed for this system are that, being self-acting, it entirely dispenses with manual labor, which at some critical moment is apt to be at fault; that its certainty of instantaneous action is secured by the concealment of its working parts, and their protection from wet and dust; and, finally, that the expense of application is comparatively small.—3 *A*, VI., 16.

A NEW MOTOR FOR SMALL MACHINES.

By a recent invention of Schneider, of Vienna, the application of steam as a motor for small machines, it is said, has been rendered perfectly successful. The apparatus is small and noiseless; and, considering the fuel consumed and attendance required, as well as the first cost, it is claimed that it affords the cheapest possible power for small machines, while, on account of the diminished size of the boiler, it is available any where, without any alterations in the buildings, as in the foundations, chimneys, etc. Pending the application for a patent, full details can not be given; but a chief feature is that the water is carried back from the cylinder into the boiler in such a way that a boiler of not quite twenty-one gallons capacity affords steam of four horse-power.—5 *C*, II., 1876, 15.

NEW OIL-CAR.

The present method of transporting oil in tanks to the seaboard involves the necessity of returning the tank cars empty—which means so much dead loss in freight to the transporting companies. A new tank car has lately been invented, which is designed to get over this objection by swinging the tank underneath a platform, which can be used as an ordinary gondola car for carrying freight on the return trip. If found successful in practice, the new design should materially lessen the cost of transporting oil to the seaboard.

A NEW PLAN OF ELEVATED RAILROAD.

An experiment was lately tried at the works of the Phœnix Iron Company, at Phœnixville, Pa., with a new form of elevated railway, which is claimed to possess decided advantages. In view of the general interest manifested in the rapid-transit problem, the following brief description of the system in question is presented, although without the aid of drawings a description must necessarily be unsatisfactory:

The railway is constructed on the plan of a single rail, supplemented by two guide-rails parallel to it, the centre rail supporting the car. The road is designed to be elevated about fourteen feet above ground-level, and the advantages claimed for it are that the guide-wheels, which maintain the equilibrium of the car, being connected with the bearing-wheels, maintain a constant position with relation to the bottom rails, however much the car may rise and fall on its springs. The short axles of the bearing-wheels, with a slight flexibility on the bearings, enable them to adjust themselves to any curve independent of the car and of each other, thus avoiding the danger of mounting the rails, and permitting very short curves to be employed. The roadway is supported on Phœnix columns placed about fifty feet apart. The engine is likewise of peculiar construction. The results obtained at the trial were pronounced to be quite satisfactory. Without the least irregularity of motion on the curve, a speed of forty miles an hour was maintained, with a car weighing 11,000 lbs., and an engine weighing 8000 lbs.—20 *D, Oct.* 14, 1875, 11.

A NEW RAIL FOR STREET RAILWAYS.

The common form of street rail possesses several disadvantageous features. Of these the most obvious and objectionable are: First, the battering down of the rail end by the sudden impact of the car wheels; and, second, the loosening of the permanent way by the gradual drawing of the spikes, due to the lever-like action of the wheels on the ends. A recent invention, which is termed a compound street rail, is claimed to have obviated these disadvantages, and to give to the road additionally greater rigidity and wearing qualities. The compound rail has its chief claim to novelty in the fact that it consists of two parts—the head and foot, or flange. A section of the rail, with the two pieces in position, would resemble that of a common street rail divided horizontally into an upper and lower piece. These pieces are so laid down that the joints or ends of each of the upper pieces or heads shall fall at the centres of the flanges. In thus breaking the joint, the lower piece is made to act as a continuous support or bearing to the rail-head throughout the whole line of rail. The sides of the flange throughout its whole length are bent at right angles to its face, and in opposite directions. This device leaves an upturned edge of about a half-inch of metal on each side, its object being to afford a brace to the rail-head, to enable it to resist the obvious tendency to lateral displacement which will be brought to bear upon it by the turning out of carts, wagons, etc., and likewise to give the flange a firmer hold upon the stringer. When the flange is worn upon the upper surface, it may be taken out and reversed, thus exposing an entirely new surface to wear. The compound feature of the rail likewise permits different materials to be used in its construction; the upper piece, for example, may be made of steel and the flange of iron, or both may be of steel. The parts of the rail are attached firmly to each other and to the wooden stringer by clamps and keys of peculiar construction. By this means the employment of spikes in the head of the rail, which would be open to grave objection, is rendered unnecessary, and the rail is more securely fastened down than would be possible by the use of the ordinary spike. The inventors claim that their rail does away with the hammering down of the rail ends by affording for the head a continuous, stiff support; that it is far more rigid and permanent than the common rail; and that its wearing qualities are greatly superior. A line of this rail is about to be laid down near the entrance to the grounds of the Centennial Exhibition in Philadelphia, where the claims of the inventors will be most thoroughly tested by the enormous traffic that must pass over it.

IRON SLEEPERS.

On the railroad lines of Alsace-Lorraine efforts are being made to create a system of steel rails with iron sleepers. Cross-girders of broad section are used to support the rails; and these are strengthened at certain distances by tension-rods, which give a steadiness of support which permits of the use of a lighter style of rail. In the same connection, it is worth recording that M. Loigné has patented a system of U-shaped grooved cross-stays of iron to replace the wooden sleeper, which latter is often found, especially in narrow-gauge roads, to take up too much room, and to occasion frequent repairs. In India iron sleepers have long been in successful use—the destructive habits of the ants rendering the use of timber quite impossible.

SINGLE-RAIL STEAM TOWAGE ON CANALS.

The following is a description of a method of steam towage lately introduced on the Bourgogne canal in Belgium. The tow-path is laid with a single rail, weighing some sixteen pounds to the yard, and fixed on traverses placed 3.2 feet apart. The locomotive has four wheels, two of which are placed directly along the axis of the vehicle, one in advance of the other, and the other two opposite each other at the sides. The first-named pair are directing, and the last-named driving wheels. The directing-wheels are grooved and fit the rail; the others have rubber tires that give purchase on the macadamized road. By means of simple mechanism the weight of the engine may be thrown either on the driving or directing wheels at pleasure. In the first case the maximum, and in the latter the minimum of adherence is obtained, to correspond to the condition of a loaded or empty boat. A single road is employed with relay engines provided at suitable distances. Each locomotive tows one boat, and when a meeting takes place of two traveling in opposite directions, the engines change boats and retrace their paths. The single rail system has already been satisfactorily tested for short distances on the Belgian canals; and the system here described will extend its application over a distance of 150 miles. The locomotives are described as weighing four tons each, and travel, according to statement, 3.1 miles per hour, with full boats carrying a cargo of 150 tons each.—17 *D*, XIX., 54.

CAST-STEEL WIRE ROPES.

According to a Prussian mining journal, cast-steel wire ropes have been substituted in many mines in Westphalia for those of iron, with excellent results. Experience in all cases, however, indicates that steel wires must be greased at least once a week, and that it is advisable to lay the rope aside upon the slightest indication of brittleness in any of the wires. At Saarbrück it has been found advantageous to use a drum of larger diameter than is usual with iron wire, owing, it is presumed, to the fact that steel breaks more readily than iron after it has passed the limit of elasticity. —5 *C*, XLVIII., 376.

SUBMERGED CHAIN FOR TOWING BOATS.

The remarkable success attending the novel system of river navigation, introduced for nearly the whole length of the Elbe River, of towing boats by the aid of a chain submerged in the channel, has led to its introduction upon the tributaries of that river. The data furnished by its operation for several years warrant the conclusion that this mode of interior navigation possesses great economical advantages, not only especially as compared with railroads, but also as compared with other modes of towing. By the former methods of towing, the necessity for the reduction of the resistance to a minimum led to the building of boats of large size, regardless of the disadvantages connected with them, such as the greater difficulty of obtaining full freight from point to point, uncertainty of running at all stages of water, etc. But besides the reduction of the size of boats allowed by the new system, it is also probable that it will be found applicable in cases where the current has been found too strong to render navigation practicable by the old method, since a boat towing by means of a firmly anchored chain passing over it is much more nearly independent of the current.—34 *C*, II., 14.

WIRE ROPES OF PHOSPHOR-BRONZE.

On account of the higher absolute tenacity and power of resisting torsion possessed by phosphor-bronze wire of certain kinds over that of iron or steel, its advantageous application in the manufacture of wire ropes for mines was anticipated. The employment of such ropes for several years in England, Belgium, and Westphalia has so completely substantiated the theoretical calculation that their use is rapidly becoming more general. Their first cost, it is true, is greater than of those of iron or steel, but, on the other hand, they afford much greater security, last at least seven times as long as those of steel, and, when unfit for use, the metal is still worth a large part of the original cost.—5 *C*, XLVIII., 385.

PEAT AS LOCOMOTIVE FUEL.

Any method of treating peat, to enable it to be utilized on a large scale, would be of great importance; in which connection it is of interest to notice that the Central Pacific Railroad Company have experimented successfully with this substance as fuel for their locomotives. Their supply was obtained from an island at the junction of the Sacramento and San Joachin Rivers in California.—4 *D*, *October* 7, 1875, 15.

THE PNEUMATIC TUBE IN THEORY AND PRACTICE.

Mr. Culley communicates to the Institute of Civil Engineers, of London, an elaborate memoir on the transmission of telegrams by pneumatic tubes. This, he says, was first carried out in 1853 by Mr. Latimer Clark for the Electric and International Telegraph Company in London. Both the compressed air and the vacuum methods have been used in England; and tubes having diameters of from one to three inches are adopted according to the necessities of traffic. The methods adopted in London appear to secure decidedly greater speed and certainty than those used in Paris. The British public, it is stated, is perhaps exacting in its demands for speed. A delay of ten minutes would be considered fatal in the metropolitan traffic. As regards the comparative cost of the pneumatic and the electric systems, it is stated that the former is decidedly less expensive, since, for instance, the total annual expense of the tube system in London, including the pay of all engaged in it, and the interest on the original cost, is barely two thirds of the pay alone of the staff that would be required to telegraph the messages. The theoretical principles which govern the flow of air through pipes, and the amount of engine-power required to produce that flow, has been very thoroughly investigated by the telegraph officials of England, and the results of their investigations are given by Messrs. Culley and Sabine in the present memoir. A number of experimental determinations were made by using the tubes when business was not pressing, and the results thus obtained appear to verify the theoretical formula.

The memoir is accompanied by extensive tables to facilitate the solution of the problems arising in pneumatic transmission.—*Minutes of the Proceedings of the Institution of Civil Engineers, London,* 1876, 53.

PNEUMATIC TUBES IN PARIS.

In a memoir by C. Bontemps on the movement of air in pneumatic tubes, a very complete account is given of the system of pneumatic transmission as at present existing in Paris. He states that when an obstruction exists any where in the underground tubes, its location is determined by firing a pistol into the tube; the resulting wave of compressed air, traversing the tube at the rate of a thousand feet a second, strikes the obstruction, and is then reflected back to its origin, where it strikes against a delicate diaphragm, and its arrival is recorded electrically upon a very sensitive chronograph, on which also the instant of firing the pistol had been previously recorded. The wave of sound on reaching the diaphragm is recorded, and thence reflected back, and a second time strikes the obstacle, and returns to the diaphragm. This operation is several times repeated, so that several successive measurements can be made of the time required by the sound-wave to traverse to and fro within the pneumatic tube.—*Minutes of the Proceedings of the Institution of Civil Engineers, London,* 1876, 105.

PRINCIPLES OF THE CONSTRUCTION OF WHEELS.

In an essay on the construction of wheels and axle-trees, Captain Kemmis, of the Royal Artillery, states that the most severe test to which spokes are subject is from the lateral thrust brought to bear upon the nave when one wheel becomes lower than the other by dipping into a rut. In order, therefore, to place them in a better position to resist this thrust the wheel is dished, or formed into a kind of dome, and just as the dome or arch is strong from its form to resist pressure upon the crown, tending to crush it in, so is the wheel made strong by the dish to resist the lateral thrust tending to throw the nave outward. In fact, not only do the spokes, sustained by the tire, give mutual support to each other, but the lateral thrust upon each becomes partly converted into a compressing strain which the wood has better power to resist. The greater the dish the stronger the wheel will be to resist the lateral strain; but no more dish should be given than necessary for the safety of the spoke, by reason of other considerations. Among these considerations the principal consists in this, that by reason of the dish form the sole of the wheel must be leveled, making the wheel conical in form instead of cylindrical. The wheel, therefore, tends to describe a circular path around the point where the prolongation of its sole would meet the prolongation of its axis. In every vehicle the wheel is compelled to move straight forward; consequently, instead of rolling, it partly slides, producing thereby a friction between the ground and it, and tending thereby to defeat the primary object of using wheels. This latter point has been minutely investigated by Colonel Close, who states that the force wasted in overcoming this friction varies directly as the square of the breadth of the tire, and as the tangent of the hollow of the axle-tree arm of the wheel, but inversely as the height of the wheel. If, then, on grounds of strength, a certain hollowing of the axle-tree arm is unavoidable, we see how essential it is to confine the width of the tire within the lowest allowable limits. Colonel Close states that, as the results of several years' experience in the manufacture of heavy carriages for army purposes, he is led to the following considerations: First, in the case of carriages loaded heavily and drawn over irregular and broken ground, a dish is of the utmost value to strengthen the wheel, whether the carriages be on springs or not. Second, in carriages not supplied with springs, and liable to carry dead loads over all sorts of country, the lower spoke should be almost, but not quite vertical. Third, if the carriage be on easy springs, considerable dishing of the wheels is admissible, without hollowing the arm. The wheels would then be cylindrical, and would roll truly. In this case the strut of the lower spoke is equal to the dish of the wheel.—*Minutes of Royal Artillery Institution*, VIII., 372, 418.

SCIENTIFIC BALLOONING.

Since the death of Crocé-Spinelli and Sivel, the taste for balloon ascensions, so far from diminishing, seems to have received a new impetus in France, in all parts of which country ascensions have of late taken place very frequently. The greater part of the aeronauts content themselves with sending some account of their voyages to the local press; but such accounts, however brilliant they may be in a literary point of view, are of little use to meteorological studies. The French Society for the Promotion of Aerial Investigation has consequently requested all the aeronauts of that country to send to it, as the central bureau, careful accounts of the voyages made by the aeronauts, giving the barometric heights, the direction and velocity of the winds and clouds as well as of the balloon, the temperatures, and, if possible, the hygrometric conditions. By thus centralizing the observations, it is believed that a great service will be rendered to meteorology. And similarly it is earnestly to be desired that the aeronauts of America, both professional and amateur, would communicate to some central body—than which none can be more appropriate than the Army Weather Bureau—the exact results of their various ascensions.

RECENT PROGRESS OF AERONAUTICS.

In reviewing the recent progress of aeronautics, Villeneuve recently stated that Henry Giffard, who constructed the first steam aerostat, had, in the course of his studies, been led to invent the injector, which is known under his name, and which has given to him both a reputation and fortune, which he richly merited.—Paul Bert, in studying the influence of barometric pressure upon animal life, was led to a process for the preservation of the bouquet and the flavor of wine.—Of the great number of aerial voyages that have been made of late, those especially worthy of mention as having for their object the improvement of aeronautics, or the application of the balloon to the study of meteorology, physiology, spectroscopy, etc., are the following: First, that undertaken on the 22d of March by Crocé-Spinelli and Sivel. These two brave aeronauts ascended to the height of 24,000 feet—a height which had never been attained before in France. At this altitude, Spinelli was able to study spectroscopically the composition of the atmosphere of the sun. In the United States, Mr. S. A. King has made some very long voyages in pursuance of meteorological studies. M. Durnof and his wife ascended from Calais on a day of public festival, and were caught by a wind which carried them to the middle of the North Sea. They were rescued by two brave English mariners. An interesting history of the balloon *Louis Blanc* has been published by Forcot, giving an account of the ascension made during the siege of Paris in the postal service.—Three balloon ascensions during 1874 were attended with the death of the voyagers; the first of these took place on the celebration of the crowning of the King of Siam, when a slave was carried up in a balloon without any provision for his safety.—For scientific applications of the balloon, meteorology takes the first rank. Their usefulness in the study of the winds in the midst of storms has been forcibly urged by Janssen, who has recently twice personally experienced the power of the typhoon, and has also established a prize medal of gold to be given to the author of the best memoir on aerostatic meteorology.—A curious apparatus has been designed by Parville for determining the true direction of the motion of the clouds, with respect to the meridian.—Self-recording meteorological apparatus has been invented by Messrs. Herve, Manyon, Olivier, and Jobert, while minimum barometers have been made by Janssen. Pénaud and Godard have devised apparatus to indicate the rising and falling of the balloon.—Crocé-Spinelli and Sivel have furnished the means for ascertaining the direction of the movement of strata of air, either above or below the balloon.—Miss Zier, granddaughter of Carcel, the inventor of the Carcel lamp, has proposed to do away with the lubricating oil, whose thickening is so injurious to the action of all self-recording apparatus at low temperatures, by mounting the movable portions of the mechanism on polished rubies.—One of the most important improvements in the gas balloon is that of Jobert, who proposes to construct one side of the gas-holder of white, and the other of black stuff, since it is easy to turn the balloon about its vertical axis by means of a small propeller, so as to keep either the black side or the white side always facing the sun, and thus, by the heating or cooling, make the balloon either to ascend or descend to an extent depending upon the difference in the reflecting or absorbing power of the two halves of the balloon. By this means we can, perhaps, control the vertical movements of the balloon to a sufficient extent to render its applications in meteorology of much importance.—

Numerous prominent aeronauts have warmly advocated the use of the hot-air balloon, the Montgolfier, and certainly these do seem highly appropriate to a certain class of meteorological observations.—Almost all the danger to the aeronaut is presented at the moment of his descent, in consequence of the difficulty of arresting the balloon without a sudden shock, and a consequent rupture when the wind is strong. Messrs. Sivel, Pénaud, and others have, therefore, made use of the friction of the anchor rope, which permits the gradual diminution of the motion of the balloon up to the moment when the anchor takes fast hold of the ground. The question of directing the movements of the balloon has, as for many previous years, been treated of by numerous persons, but, in general, without any great advance toward the desired end. It is but a step from the attempt to direct the passage of the balloon to the attempt to imitate the flight of birds, and in this branch of aeronautics there has been witnessed a marked advance. Important memoirs on this subject have been presented by Marey, Pénaud, Pettigru, and others.—A remarkable apparatus has been constructed by Grouchot for studying, by direct observation, the movements of the wings of birds.—*La Aëronaute*, 1875, 13.

AERONAUTICS IN THE ARCTIC REGIONS.

Sivel, in 1872, laid before the French Aeronautic Society a proposition for an exploration of the North Polar regions by means of balloons; and the idea has lately been treated of by Martinet, who states that Sivel's original project was the first that seemed to be worthy of serious attention, and to present practicable features. His idea was to make use of a large balloon filled with hydrogen, and so constructed as to remain for months in the air, to effect which latter desirable object Sivel indicated the exact means in order to keep the balloon at an altitude of about 2500 feet. Special means were necessary to overcome the variable effect of solar radiation, which, as is well known, produce variations in the altitude of a balloon to the extent sometimes of more than three thousand feet. Thus in the voyage of Janssen on the 22d of December, 1870, they were forced to seek an altitude of from nine to thirteen thousand feet, in order to escape being plunged into the surface of the sea by the oscillations due to the heat of solar radiation.—*La Aéronaute*, 1875, 287.

THE PARAKITE.

An English aeronaut has lately invented a flying-machine to which he gives the above name, and with which a tolerably successful experiment is said to have been made at the Alexandra Palace. The machine in principle is substantially a kite, and like this is held by a cord, on the severance of which, however, the inventor affirms the apparatus will descend as safely and securely as a parachute. In the experiment referred to, the machine employed was thirty feet high and thirty feet wide. As soon as the sail was over the framework and the front or windward point of the parakite was raised, so as to allow the wind to touch the machine on its under surface, it was instantly converted into a concave form, and manifested symptoms of rising. The wind was blowing at the rate of about two miles an hour, but with this slight breeze Mr. Simmons was carried into the air. The inventor claims that his device can be used successfully in any wind ranging between four and forty miles an hour, and that an altitude of from six hundred to one thousand feet may be attained. The machine used on the occasion above named covered an area of seven hundred superficial feet, and its weight (exclusive of its occupant) was one hundred pounds. On a previous occasion some trials were made with a small parakite carrying a two-pound weight, which several times attained an altitude of one thousand feet, and remained tolerably steady, though its descent was rather rapid. These experiments, it is said, will be repeated, with the view of determining the practical utility of the device.—3 *A*, VI., 426, 490.

FLUID-COMPRESSED STEEL AND GUNS.

In a paper with the above title, read before the Institution of Mechanical Engineers, Sir Joseph Whitworth remarked that the difficulty he experienced in obtaining sound, ductile steel had induced him to institute experiments in compressing steel while in the fluid state. He affirmed that crucible steel for constructive purposes was largely superseded by the metal produced in the Bessemer converter or the Siemens furnace; and although the crucible steel was yet occasionally demanded on account of its supposed superiority, nevertheless its superior quality, when it existed, would be found to be due to the use of purer and better materials. In substantiation of his opinions he exhibited specimens of fluid-compressed steel. For guns, torpedoes, boilers, etc., Sir Joseph stated that the quality of elongation was of the first importance, as well as generally, wherever severe strains were suddenly employed. He said that it was now possible by the compression of fluid metal to produce with certainty steel that would bear a tensile strain of forty tons to the square inch, and which elongated thirty per cent. of its length before breaking. He urged, in conclusion, that guns should be constructed of steel, and steel only. He detailed the results obtained in the experiments with his breech-loading guns, and added that the War Department were now making guns of enormous size and weight, but maintained that this great size was unnecessary, for the reason that, if monster guns were wanted, they could be made by means of the Siemens-Martin furnace and fluid compression at much less cost, while with regard to the quality of materials employed every thing favored the modern processes. On the subject of projectiles, the speaker asserted that long projectiles gave greater penetration at both long and short ranges, and also a much lower trajectory, except at the lowest elevations, for short distances, and he declared in favor of the polygonal system of shot over the French studded system adopted at Woolwich.—3 *A*, VI., 139.

RANGE-FINDER FOR ARTILLERY PRACTICE.

The range-finder of Captain Nolan of the Royal Artillery has been in use to a limited extent for some years, but a full account of the instrument, with tables for its use and instructions for its employment, both by infantry and artillery, has only lately been published by him. This simple instrument can, according to him, give the correct distance of an object in such a way and so quickly as to be perfectly applicable to the use of a battery in the field. Its success seems to have been so great in England that it is improbable that any instrument differing essentially in construction from it will be likely to supplant it. The cost of the artillery practice at unknown range, while manœuvring rapidly, shows that a large quantity of ammunition may be wasted without the effect being observable from the battery, and points to the necessity of some means being provided for ascertaining in the field, and within reasonable limits, the distance of the object to be fired at. Captain Nolan's apparatus is fitted to two of the guns of a battery, and enables the distance of the object to be determined with sufficient accuracy after firing two or three rounds.—*Min. of Roy. Artillery Institution*, VIII., 161.

SHARP ARTILLERY PRACTICE.

At the siege of Strasburg the Prussians used for breaching purposes a short six-inch gun firing a special long shell weighing about sixty pounds. The method of breaching consisted in making a horizontal cut at a height from the bottom equal to one third of that of the wall; and when this cut was supposed to be satisfactorily effected, vertical cuts, if necessary, were made, the continued firing eventually bringing down the wall. The fact that the horizontal cut was satisfactorily completed could generally be decided by the sound of the concussion and explosion of the shell, by the nature of the fragments whirled into the air, and by the appearance of the smoke from the explosion of the projectile, it being, if delayed, of a dark-gray color, and slow in rising if the masonry had been broken through. One of the chief sources of strength of the fortress of Strasburg consists in the obstacles presented by different water ditches, and by the extensive inundations which can be formed in its vicinity. The French, by damming up the Ill and utilizing the sluices, had filled not only the ditches and the whole country opposite the south front, but had inundated a great part of the ground of the left flank of the attack. The plans of the fortress showed the besiegers that by the destruction of two particular sluices, the water upon the ground and in the ditches would be reduced to a very low level; but neither of the sluices could be seen from any part of the attacking lines. Neither did the inaccurate maps afford sufficient data by which to point the guns. It was known that the sluice was near a turret, and a certain turret was fired upon, until, by the firing, its exact distance was determined. Plotting this upon the chart, it was then found that this could not be in the neighborhood of the sluice. A second turret was fixed upon, which, being also plotted upon the chart, was, it was evident, the right one. A number of shots were then fired at this turret in order to determine the point of mean impact, and by means of the necessary corrections it was possible to calculate the point of medium impact for the middle of the face of the turret; and thence by another transfer to compute the elevation and deflection for a point on the sluice just above the water-level in the ditch. A reference to the practice tables showed that at this range—a little over one mile—about eight or ten per cent. of the projectiles might hit the small sluice-gate at which they were aimed. An examination with a good glass showed, by the showers of water, wood, and stone, whether the sluice was hit or not. The bombardment continued with two guns, which were so pointed that two shots should strike on the face of the sluice about thirteen inches apart. After the fall of Strasburg it was seen that this sluice was very strongly built. Huge cut stones about six feet thick formed the faces of the water sluice-gates. The bombardment had nearly destroyed these gates, and had displaced or destroyed the stone-work, and the water in the ditches had been visibly lowered. Great attempts had been made by the French to repair the damages. —*Minutes of Royal Artillery Institution*, VIII., 143.

ROTATION OF RIFLED PROJECTILES.

In a recent paper by Captain Noble there are given the results of some investigations into the absolute values of pressures exerted by projectiles, in rifled cannon, against the spiral flange or groove by means of which rotation is given to the shot. This pressure, of course, depends on the angle of the rifling. In certain systems of rifling studs may have scarcely any work to do at the muzzle of the gun, while they may be severely strained at the commencement of the motion; by which means an unnecessarily severe strain is produced, tending to injure the gun. According to Captain Noble's investigations, guns should be rifled with an increasing twist. If rifled with a uniform twist, it is possible, as in a case quoted by him, that the pressure on the studs may amount to sixty-eight tons during the first six inches of the shot's movement, but have diminished to nine tons by the time the shot leaves the muzzle; whereas in the case of the accelerated parabolic twist, as ordinarily constructed, the pressure varies from twenty-nine tons at the beginning to twenty-six tons at the muzzle. Among the other results at which he arrives, he states that in the ten-inch gun the pressure on the studs due to rifling is but a small fraction (about two and a quarter per cent.) of the pressure required to give translation to the shot, and that the increment of the gaseous pressure, or the pressure tending to burst the gun, due to rifling, is exceedingly small. Both in the case of the uniform and the parabolic rifling these theoretical results are entirely confirmed by the experiments of the Explosive Committee of the Ordnance Bureau, who have found no sensible difference of pressure in the ten-inch gun as fired in the rifled and unrifled state.—*Minutes of Royal Artillery Institution*, VIII., 367.

SILICATE COTTON.

Krupp, of Essen, the well-known cannon manufacturer of Germany, employs a preparation which, under the name of silicate cotton, he considers to be a most admirable nonconductor. It is made from blast-furnace slag, and is in the form of a spongy or cotton-like fibrous elastic substance, and is so light that one ton will cover five hundred and sixty square feet to a depth of two and a half inches. One of its advantages as a non-conducting covering for steam-boilers, heated pipes, etc., besides its absolute indestructibleness, is that it is very porous, and allows the ready passage of moisture, so as to show at once the existence and position of any leak. In application it is wrapped around the article, bound with wire, and covered with canvas.

The same substance under the name of "mineral wool" has been in use in the United States for similar purposes.—18 *A*, *Jan.* 7, 1876, 422.

LIGNOSE, A NEW EXPLOSIVE.

According to the *Industrie-Zeitung*, the new explosive, lignose, apparently woody fibre prepared with nitro-glycerine, invented by Trützschler-Falkenstein, is a very light powder, which in a loose condition burns very slowly. The cartridges made of it are larger than those of ordinary blasting-powder of the same power. As it does not withstand moisture, it can not replace dynamite. It has been employed in a number of mines, and the results of tests made of it, although not unfavorable, place its explosive force, which, however, does not seem to be uniform, at at least three times that of an equal weight of blasting-powder, instead of at five times, as claimed at first; the price has therefore been fixed by the manufacturer on the basis of the former, at something less than that of an equivalent quantity of powder. Great safety is stated as one of the advantages of its use, as it is said not to be exploded by contact with naked fire, and with difficulty by friction or percussion, while it can be used with a fuse in blasting. It is also said that but little, and that harmless gas, is left after explosion. In the *Polytechnisches-Centralblatt*, however, an account is given of an explosion and the destruction of the building in which cartridges of it were prepared by women, by stamping it into cases, although, according to tests made under governmental supervision, the occupation had been pronounced perfectly safe. The combustion of the cartridges, when first noticed, was so slow that twenty-two out of twenty-three persons employed escaped unhurt before the explosion occurred.—6 *C, September* 23, 1875, 375, *and* 13 *C, July* 1, 1875, 851.

INFLUENCE OF HEAT ON THE EXPLOSIVENESS OF NITRO-GLYCERINE.

Sergius Kern, of St. Petersburg, has been studying the effect of heat upon nitro-glycerine. The sample examined had a specific gravity of 1.6, and solidified at 4° Centigrade to a crystalline mass. At 187° it entered into ebullition, with separation of orange-colored vapors; at 220° it exploded strongly, at 262° more violently, and at 294° the explosion was very feeble, being accompanied by a yellowish flame. In other words, the explosive properties of the substance nearly vanished at a high temperature.—1 *A*, XXXIII., 153.

EXPERIMENTS WITH PRISMATIC GUNPOWDER.

In the course of some experiments made by the permanent Austrian Committee, it is noted that the Austrian prismatic powder has a smaller kernel and a less density than that ordinarily employed in Prussia for six-inch cannon; and the result of the experiments made with this powder shows that the maximum pressure exerted by it upon the common ball amounts to 2520 atmospheres, being about 200 atmospheres, or 3000 pounds to the square inch, greater than the pressure developed by the Prussian prismatic powder.—*Mittheilungen Oesterr. Hydrogr. Bureau*, II., 13.

RESEARCHES ON EXPLOSIVES.

MM. Roux and Sarrau lately presented an interesting memoir to the French Academy, on certain phenomena presented by explosives. They find that two kinds of explosions can be manifested by the majority of explosive substances, according as they are made to deflagrate (explosion of the second order), or to detonate, as by the percussion of fulminating powder (explosion of the first order). They find, furthermore, that the energy of the explosion produced by the same quantity of the explosive is very different in the two cases, being invariably more powerful where detonation was employed as the inciting cause, as will be seen from an inspection of the following table, in which the explosive energy of gunpowder exploded in the ordinary manner is taken as unity:

	Explosive Force.	
Name of Explosive.	Second Order.	First Order.
Mercury fulminate	——	9.28
Gunpowder	1.00	4.34
Nitro-glycerine	4.80	10.13
Gun-cotton	3.00	6.46
Picric acid	2.04	5.50
Potassium picrate	1.82	5.31
Barium "	1.71	5.50
Strontium "	1.35	4.51
Lead "	1.55	5.94

Of these results, the most interesting and valuable is the fact that the detonative explosion of gunpowder, induced by the detonation of nitro-glycerine (which last is in turn detonated by fulminate), produces an explosive energy more than fourfold greater than that obtained by igniting powder in the usual manner.

STEAM FOG-WHISTLES.

It has been found by General Duane, of the United States Engineers, in his experiments made to determine the best form of boilers for steam fog signals, that as the steam used is at a high pressure, and is drawn off at intervals, there is a constant tendency to foam and throw out water with the steam. To counteract this, a horizontal tubular boiler, like those used in locomotives, is recommended by him. The steam-dome must be very large, and surmounted by a steam-pipe twelve inches in diameter. The steam should be drawn off at a point ten feet above the water-level in the boiler. The diameter of the boiler whistle should be two thirds of its length, and the vertical distance of its lower edge above the coping for a steam pressure of fifty pounds should be from one third to one fourth of the diameter.—*Elliott's European Light-house System*, p. 25.

THE ELECTRIC LIGHT-HOUSE AT SOUTH FORELAND.

In the light-house at South Foreland the electric light is employed, and the electric current is generated by means of large magneto-electric machines, which are driven by belting connected with a steam-engine. Each machine is composed of 96 helices, mounted upon six gun-metal wheels, each of which carries 16 helices. Between these wheels are placed the magnets, eight in each division, 40 of which are composed of six layers or leaves riveted together, while the 16 end ones have but three leaves each. The magnets, which are mounted in frames, are stationary, while the helices revolve at the rate of 400 revolutions per minute. The power absorbed by the electric machine alone, including friction, is four indicated horse-power. The power of a magneto-electric machine is according to the gross attractive power of its magnets, each magnet having a certain lifting or attractive power expressed in pounds. In the machines at South Foreland each of the six-plate magnets will lift 108 pounds, and each of the three-plate magnets 54 pounds, making the attractive power of the magnets in one machine to be 5184 pounds. The proportion of the lifting power to the weight of a magnet is a good indication of its value, and, generally speaking, a magnet which will lift two and a half times its own weight is a good one. Each six-plate magnet at South Foreland has a weight of 43½ pounds, or two fifths of 108 pounds. The machines are connected by underground cables with the electric lamps placed in the lenses of the tower. The carbons used in the lamps are ten inches long by three eighths of an inch square; they are regulated by an automatic apparatus, and consume at the rate of four inches per night for each lamp. The lenses are about the same size as ordinary third-order lenses.—9 *D*, *March* 6, 1875, 55.

THE USE OF GAS FOR LIGHT-HOUSES.

The great advantage of employing gas for light-house purposes is stated to consist in the fact that, by a very simple arrangement, the number of burners and the brilliancy of the flame can be increased from its ordinary to an extraordinary brightness, such as to provide for its visibility in all kinds of thick weather, except, of course, that condition of fog which no light, not even the sunlight, can penetrate. In a fixed-light apparatus, of any size, there is no occasion to alter the existing lenses if we wish to introduce the use of gas instead of oil; but in some lamps it may be necessary to provide for additional ventilation. The cost of gas-light is said to be less than that of oil, while the photometric value of the flame of gas is largely superior to that of any kind of oil. When the "fog-power" of the gas-light is turned on, the cost of the gas per hour is greater; but taking the average of a year's consumption, at several light-houses, it appears that there is an actual saving of about $300 per year by the use of gas. A very simple apparatus effects an automatic intermission in the light, which not only saves somewhat in the consumption of gas, but acts as a means of distinguishing one light-house from another, precisely as is at present brought about by the introduction of the flashing system. A gas-light of the first order, employing Mr. Wigham's gas-burners of 108 jets, would, if fixed, be equal to 70,000 standard candles; but, if revolving, be equal to 873,000 candles.—*Elliott's European Light-house System.*

THE ELECTRIC LIGHT FOR SIGNALING.

A series of experiments has lately been made at the celebrated Siemens-Halske Telegraph Works, in Berlin, with the object of testing the adaptability of the electric light for signaling purposes. The apparatus in question, which was operated from the roof of the factory, to the great astonishment of the populace, gave a light so powerful that ordinary writing could be read by its illumination at the distance of a mile. It was arranged within a closed mirror in such a manner that the beam of light was projected against the clouds, which served as a screen. In front of the mirror the signals were made, which were duplicated upon the clouds on a gigantic scale. This process, it is said, is to be adopted by the German army for night-signaling.—6 *D*, XXXIII., 281.

FOG-SIGNALING BY EXPLOSIVES.

Major Maitland, of the Royal Gun Factory at Woolwich, recently delivered a very fully illustrated lecture before the Royal United Service Institution on fog-signaling by means of explosives; a lecture which was a continuation of a previous address by Vice-Admiral Collinson on the use of horns, whistles, the siren, etc., as fog-signals. Major Maitland states that three kinds of guns were experimented upon by the Trinity Board with regard to their appropriateness as signal guns; and that body decided to apply to the War Office for a solution of the following problem: "To produce the most far-reaching sound possible with a charge of three pounds of powder, and to enable two men to keep up the firing at intervals of not more than five minutes during a long-continued fog." The problem divides itself into two parts: the ease of working and the propulsion of sound. With regard to the latter and more difficult question, he states that the designing of a gun is a simple problem, but the production of sound is quite another matter. We have hitherto looked upon the noise of a discharge as a necessary evil; now, however, we have to investigate the cause of the report of the gun, and seek to construct such an apparatus as will give the greatest noise with the least possible expenditure of powder. The sound of a discharge is made up of two factors; one, the blow struck by the expanding gas on the still air at the muzzle of the gun; the other, the vibration of the metal of the gun. It is found that when a gun is fired, a great difference in the intensity of the sound is experienced by the observer, according to whether he places himself a little before or behind a line drawn at right angles across the muzzle of the gun. It would appear that the rapidly expanding gas strikes a violent blow on the air in front of the muzzle, and, failing to drive the mass of air at once, sends its vibrations forcibly out on all sides. In order to catch the vibrations passing to one side of the muzzle and cause them to be propelled forward, it was proposed to enlarge the mouth of the gun into the form of a widespreading cup. It is not easy to ascertain precisely the distance in front of the muzzle at which the expanding gas strikes with the greatest force; but it is tolerably clear that when this point is once ascertained, it may be made the focus of a parabolic cup. A series of small experimental cannon with plain muzzles, conical and parabolic mouths, were then cast, and it was found that conical cups had a decided superiority over parabolic cup-shaped mouths. Experiments were also made on the comparative merits of gunpowder and gun-cotton, the experiments with the latter substance being carried out by Professor Abel; the result of which latter was that the gun-cotton, when exploded in the focus of the parabolic reflector, was decidedly superior to the effect of gun-cotton exploded in the open air, and in either case superior to that of gunpowder. A further series of experiments at long ranges, however, showed that while conical mouths, as above stated, are superior for short distances, the parabola gained the victory at long ranges. Experiments made on the kind of wad showed that a wooden block was superior to a junk wad; the latter, in its turn, being superior to the *papier-maché* wad. In conclusion, he stated that the experiments thus far made must be considered as only preliminary to those necessary in order to arrive at a full knowledge and definite conclusions on this important subject.—*Journal Royal United Service Inst.*, 1875, 481.

CARRIER-PIGEONS.

M. Laussedat communicates to the French Society for Aerial Navigation the result of some observations on the flights of carrier-pigeons. He states that he has been engaged in organizing a system of carriers for military purposes. Twelve pigeons were taken from Paris to Moulin, distance two hundred and seventy-one kilometers. The direct line from Moulin back to Paris being marked out for the use of the trained pigeons, they were observed to follow the mark very closely, and, according to a dispatch subsequently sent back to Laussedat, who remained at Moulin, it appears that seven of the pigeons arrived together at their home in less than three hours, having accomplished the distance at an average of ninety kilometers per hour. Two arrived a little later, and the tenth stopped on the way. The atmospheric circumstances were, it is true, favorable; the wind was blowing from the south to the north, there were very few clouds, and the temperature quite moderate. The pigeons which accomplished this remarkable flight came from the Somme. In order to obtain a good race of carrier-pigeons, it is considered necessary to cross the Anvers with the Liège breeds. The City Council of Paris is about to offer a prize for the best pigeons which are all of foreign breeds. A prize will perhaps also be offered for the best purely French breeds.—*La Aéronaute*, 1875, 248.

UNDERGROUND TELEGRAPH LINES.

A system of laying underground telegraph lines has been devised by Mr. A. Holtzman, of Amsterdam, Holland, which is said to have stood the test of two years' severe practice with most satisfactory results. His method consists substantially in having a trough, or gutter, of cast iron (or other material), which is filled with a peculiar bituminous insulating composition which the inventor calls *brai liquide*. The trough, or gutter, is placed at the bottom of a ditch dug in the earth, and the telegraph wires, covered with gutta-percha, are separately submerged in the composition; this done, a cover is fastened upon the trough and the ditch filled up with dirt. The composition soon solidifies, and retains the wires in excellent insulation, protecting them, at the same time, perfectly against moisture and decay. The system is also affirmed to be comparatively inexpensive. A line of some forty miles laid down upon this plan near Amsterdam, after two years of trial, is said to have proved itself completely successful, although laid in a bad and swampy soil.—6 *D*, XXXII., 307.

EXTINGUISHMENT OF CONFLAGRATIONS.

An elaborate paper has lately been presented to the Kansas City Academy of Sciences, and printed by its order, upon the "Prevention and Extinguishment of Conflagrations," by Mr. Theodore S. Case. In this he considers the various means of prevention, under the following heads: First, by the exclusion of oxygen and atmospheric air; second, by fire-proof coatings of the combustible materials used in the construction of buildings; third, by rendering such materials themselves essentially incombustible; fourth, by rendering bedding, clothing, scenery of theatres, etc., incombustible; fifth, by mechanical obstructions, such as fire walls, shutters, etc.; sixth, by the avoidance of the causes of spontaneous combustion.

The extinguishment of fires is treated of under the following heads: First, by means of ordinary water; second, by means of water holding in solution gases which are non-supporters of combustion; third, by means of such gases applied directly to the flames by machinery; fourth, by means of gases and vapors generated by the heating or combustion of certain materials with which the timbers were coated or otherwise protected previously to the erection of the building.

These various methods are all taken up *seriatim* and discussed with much minuteness, and the whole paper is one that should receive the attention of insurance companies and other bodies interested in the preservation of property from fire.

SULPHUR AS A FIRE EXTINGUISHER.

A well-known French savant suggests in *Les Mondes* that brimstone should be carried on board every ship for use in case of fire. Half a hundred-weight of sulphur will be sufficient to abstract the whole of the oxygen from 3500 cubic feet of air, thus unfitting it to support combustion; and the writer remarks that in a closed space, like a ship's hold, the sulphurous gas produced by the burning of the sulphur will penetrate where water from the decks can not be brought to bear, while the density of the gas will prevent it from rising and spreading if pains be taken to properly close the hatches. The suggestion is offered that the brimstone be made up in the form of matches of considerable size, the ends of which can be passed through scuttles prepared for them in the decks or bulkheads.

The foregoing recalls an assertion that has emanated from several independent and trustworthy sources, namely, that the vapor of chloroform possesses to a remarkable degree the power of extinguishing the flame of certain highly combustible substances, and especially that of burning petroleum. By pouring a small quantity of this substance upon such a burning mass of oil, it is affirmed that the flame will be at once extinguished, and that, furthermore, a small quantity added to petroleum notably reduces its tendency to ignite. No attempt, as far as we are aware, has yet been made to utilize this singular property.

EFFECTS OF TEMPERATURE ON THE ST. LOUIS BRIDGE.

In the construction of the great steel bridge at St. Louis, with its arches of 500 feet, calculations and allowances were made for expansion and contraction by heat and cold through a range of 140° Fahr., and the calculated difference in the elevation of the centre arch of the upper chord above the City Directrix on the hottest day of summer to the coldest day of winter was about 18 inches. Ever since the completion of the bridge, the height of the centre piers of the top chords of the arches above the City Directrix has been noted almost daily at temperatures which have ranged from 92° to 15° Fahr., and with the following results (the height is that of the centre pier of the top chord above the City Directrix):

Date.	Temp., 3 P.M.	Height in Feet.
May 6, 1874..............	69° Fahr.	63.548
June 29, 1874.............	77° Fahr.	63.688
July 20, 1874.............	91° Fahr.	63.757
Jan. 4, 1875..............	10° Fahr.	63.241
Jan. 9, 1875..............	15° Fahr.	63.065

Between the temperatures of the 20th of July (the hottest day of last summer) and the 9th of January (the coldest day of last winter) there is a difference of 106° Fahr., and a difference in height of 0.692 foot, or nearly 8$\frac{5}{16}$ inches. The actual effect upon the structure, it will be observed from this statement, is much less than the calculated effect (which, for a variation of 107°, should have given a difference in height of nearly 14 inches). The difference is explained to be due partly to the protection afforded by the roof of the bridge, and partly to the fact that the iron-work is painted white, thus lessening the absorption of heat.—*Corresp. Railway World, Philadelphia.*

THE CONSTRUCTION OF REVOLVING DRAWBRIDGES.

Mr. Clemens Herschell has presented to the American Society of Civil Engineers a paper on the principles of the construction and calculation of the strains in revolving drawbridges, and his work has an important value as one of practical interest to the profession of engineers. The calculation of continuous girders was first undertaken by Navier in 1830, but was much improved upon by M. Classeyron in 1857. These and other authors have, however, Mr. Herschell states, developed only special cases, and he has undertaken to develop the equations for the general case of unequal spans and supports, either in or out of level. Following the equations given in a recent work of Weyrauch, Mr. Herschell gives in detail the formulæ necessary to compute the dimensions of every part of the bridge in question, and illustrates the whole by numerical examples. The several equations are written out in full, and are so clear as to enable any one to follow the processes with ease. A couple of tables, showing the strains experienced by every portion of a bridge under certain loads, gives a very lucid view of the relative strength demanded in the various portions of the structure. —*Transactions American Society of Civil Engineers, March*, 1875, 395.

THE PROPER CONSTRUCTION OF SEWERS.

A report has lately been made by a committee of eight of the most eminent civil engineers and professors of Great Britain to the British Association for the Advancement of Science on the subject of the treatment and utilization of sewerage, which contains very valuable suggestions as to the proper construction of sewers. These suggestions are the more worthy of careful attention from the fact that not only are our city sewers at the present time badly constructed and of indifferent materials, but, in addition, there appears to prevail a mistaken and dangerous idea that it is better to build with loose joints, in order to allow of the percolation of the sewer contents through the subsoil. The importance of an intelligent and authoritative utterance upon these points is vastly more pressing at the present day than ever before, since the practice of connecting water-closets with the sewers in the cities and larger towns has, of late, greatly increased. The following extract from the committee's report deals very fully with the subject in hand, while at the same time it manifests the gravity which the members attach to the matter: "The committee made a special investigation into the sewerage arrangements of the town of Cambridge, where water-closets are general, though not universal. The outlets of all the sewers were found to be under the level of the surface water in the River Cam, so that the sewerage is backed up into the sewers for a considerable distance, and the subsoil is constantly saturated with both water and sewerage in the lowest parts of the town. As many of the sewers are old and of irregular shape, much escape of the sewerage into the subsoil must take place. Inquiries were made into the state of some of the water-wells belonging to private houses, and it was found they were all contaminated by sewerage, owing to their proximity to the sewers in the streets and to the drains on the premises, so that the water can not be used for drinking, but only for washing. The chief general importance of the inquiry into the condition of Cambridge is the proof thus obtained of the contamination of wells, and therefore of subsoil, by the agency of pervious street or house sewers constructed in their vicinity; and the sub-committee gave expression to the conviction forced upon it in the course of its inquiries that all sewers, properly so called (that is to say, drains into which the refuse from human habitations is admitted), ought to be constructed of materials which are altogether impervious, and that a separate system of pervious drains, similar to agricultural drains, should be constructed where necessary to dry the subsoil. The sub-committee is of the opinion that the further construction of pervious sewers should be prohibited by Parliamentary enactment."

A NEW DRY-DOCK.

To meet the exigencies of an increasing coastwise and foreign commerce at the port of Philadelphia, a new dry-dock has lately been completed by the Messrs. Cramp & Sons, builders of the American line of steamships. The location of this structure, the want of which has of late been severely felt, is on the site of their present marine railway on the Delaware front, foot of Palmer Street. The dimensions of the dock are 462 by 111 feet. It has required 4200 piles, and the basin is, of course, made water-tight by sheet piling. The pumping capacity, to be supplied with four centrifugal pumps, possesses an aggregate water-lifting power of 120,000 gallons a minute. The dock will accommodate ships of the largest size, being 100 feet longer than the ships of the American line.

THE EFFECTS OF LEVEES.

According to the Board of Commissioners on the reclamation of the alluvial basin of the Mississippi River, the idea is utterly without any good foundation, either in theory or experience, that the deposit made on the river banks must settle on the bottom, and that thus the effect of embanking a river is to confine its sedimentary matter to the channel, ultimately raising the bed, and with it the high-water mark. This idea is usually defended by appealing to the example of the Po, in Italy, which river is asserted to have raised its bed several feet. In point of fact, such is not the case. It has been shown in the most conclusive manner, by the great Italian hydraulic engineer, Lombardini, that there is no ground whatever for believing that levees ever produced the slightest elevation of the bed of the Po. The same truth is demonstrated by eighty years of observations upon the River Rhone, and by careful measurements upon the Mississippi. Another theory, diametrically opposed to this, is equally erroneous, at least as far as regards the Mississippi. It is asserted in the most confident manner that that river is flowing in a bed composed of its own deposit, with dimensions regulated in accordance with its own needs, and hence, with the increased velocity resulting from the confinement of its volume between levees, will rapidly excavate this bed to a corresponding greater depth, thus avoiding any permanent increase in its high-water mark. After reviewing various considerations, the committee state that we are to conclude that there is no mysterious agency which may be accepted as exerting a controlling influence upon the levee system; and by considering what experience has taught respecting the levees of the Mississippi during the past century and a half, it seems certain that the alluvial regions of that river can only be reclaimed by levees. The vast crops of cotton, sugar, corn, and rice, with all the existing wealth represented by lands in cultivation, its villages, plantations, and stock, are the direct fruits of this method of protecting the country against overflow.

Nevertheless it is true that the practical application of the system is fatally defective, and that unless some radical improvement be made, no hope remains of opening to cultivation the immense districts of back lands now exposed to annual inundation by reason of annual breaks in the levees. The defects of the present system may be classified as due to erroneous organization of the levees, insufficient elevations, injudicious cross sections and poor construction, inadequate arrangements for inspecting and grading, and faulty locations of the embankments, which are often placed so near caving banks as to insure an early destruction. The plan recommended by the committee consists, first, in keeping open the Atchafalaya and the La Fourche, and, if practicable, the reopening of the Plaquemine. Second, in a general levee system extended from the head of the alluvial region to the Gulf, and including the valleys of the tributary streams. The country is divided into these natural drainage districts, each of which should have a responsible chief engineer, clothed with ample powers. Without some strong and simple organization, it is the deliberate opinion of this Commission that the alluvial region can never be securely protected against overflow.—*Rep. of Comm. of Engineers*, p. 31.

NEW HYDRAULIC CEMENT.

A French chemist has succeeded in producing a mineral composition which, it is claimed, surpasses hydraulic cement in its use as a mortar, and in its resistance to the action of water, while it is also said to be unaffected by air or acids, and to acquire a stony hardness at 230°, which it retains even in boiling water. It is prepared by subjecting a mixture of nineteen pounds of sulphur and forty-two pounds of pulverized stone-ware and glass to a gentle heat, sufficient to melt the sulphur, and stirring it until it forms a perfectly homogeneous mass. It is then run into vessels and allowed to cool. It melts at about 248°, and can, like asphaltum, be repeatedly used by heating it gently.—5 *C*, XXXVII., 295.

DUBOIS' PEINTURE HYDRAULIQUE.

At the recent French Maritime Exhibition, one of the most interesting exhibits consisted of several large iron plates, inclosed by cords and sealed by the Department of the *Ponts et Chaussées* as having remained under water, submerged in the sea, for a period of eight consecutive months. These plates are exhibited by M. Dubois, in order to show the qualities and merits of his *peinture hydraulique*—hydraulic paint—or anti-fouling composition, and, if accounts may be credited, they bear conclusive testimony to the excellent qualities of the composition. In one case, we learn, about half of the plate was left untreated, the other being duly coated with M. Dubois' preparation; with the two others, one half was coated as above with the hydraulic paint, while the other half was treated with the compositions of a similar kind most in vogue in France. In all three cases, our informant proceeds, the half of the plate treated with the Dubois preparation was found to be perfectly free from rust, as well as from all outgrowth or incrustation of weeds and shells; remaining, in fact, as clean and bare as on the day when it was immersed. The advantages claimed, and thus demonstrably established, for this anti-fouling composition are its cheapness, solidity, and durability, and the extremely valuable quality of preventing oxidation and the adherence of mollusks and sea-weed. These qualities, it would seem, should make the preparation admirably adapted as a protecting coating for iron and copper-sheathed ships.—*Iron Age*, VI., 451.

THE AQUOMETER.

A new steam-pump with the foregoing name was on exhibition at a late fair of the American Institute. In external appearance, as well as in construction, it bears a strong resemblance to the apparatus known as the Pulsometer, which is doubtless well known to our mechanical readers. The following description of the Aquometer will explain the principles of construction and action. There are two working chambers combined with an interposed pressure chamber. According to the position of a steam-valve, the steam enters one chamber or the other, and presses on the surface of the water in the chamber, forcing the same out. As soon as the live steam reaches the discharge port, its free escape produces a reduction of pressure in the working chamber. The discharge-valve then closes, the steam-valve cuts off further entrance of steam, and the body of water in the central pressure chamber opens the suction-valve and causes an instantaneous condensation of the entire volume of steam in the working chamber, so as to produce a vacuum therein, the consequence of which is to fill the said chamber with water. The suction-valve then ceases, and the momentum acquired by the water flowing up the suction-pipe operates to fill the pressure chamber. As the one chamber is thus filling, the steam current operates to force the water out of the opposite chamber, so that a constant flow is kept up in the discharge pipe. The steam-valve is balanced, and means are provided to prevent injury by dirt or grit.—6 *D*, XXXIII., 273.

VERTICAL MOVEMENT OF VESSELS UNDER HIGH SPEED.

A well-known builder of fast steam-vessels, Mr. Thorneycroft, proves that at high rates of speed the body of a vessel actually rises above its normal load water-line, and as the speed is increased continues to rise still higher. This conclusion was reached from experiments conducted with a steel torpedo launch lately built for the Austrian government, and with which a speed of 19.4 knots was attained. The differences in level were determined by means of three plumb-bobs hanging from a bowsprit, at various distances in front of the bow, from observations with which the altered water surface was measured, and some very instructive diagrams made therefrom. From these it was shown that up to a speed of about 12 knots the vessel sank more deeply in the water, but on being driven to a higher speed she seemed to make an almost sudden leap upward, and continued gradually to rise above the normal water-line as the speed increased—6 *D*, XXXIII., 276.

INFLUENCE OF WIND ON PROJECTILES.

Since the introduction of rifled guns it has become a matter of importance to eliminate, as far as possible, every cause of incorrectness in artillery practice. One of the chief of these is the force of the wind; and Major Maitland, of the Royal Artillery, endeavors to supply the means of making the requisite corrections, so that we may be able to foretell how much the range will be increased or diminished by the wind, and what allowance should be made in the direction of the projectile to the right or left. The results of Major Maitland's observations are of value to others besides military authorities, inasmuch as they give a means of determining the velocity of the wind at considerable elevations above the ground. The theoretical investigations given by him depend perhaps too much upon the assumption that the pressure of the wind against the projectile is inversely as the square of the velocity of the wind, according to the formula of Sweaton. But the actual observations quoted by him form an acceptable contribution to our knowledge on this subject. A wind whose velocity is estimated at twenty miles an hour produces, according to his observations, a deviation of thirty-eight feet in a range of two miles, the diameter of the projectile being six and a quarter inches.

THE BRAYTON READY MOTOR.

Mr. Brayton has lately brought before the public a gas-engine, in which sixty pounds' pressure may be generated within the space of one minute, and which can be started by the application of a match with almost the facility that gas may be lighted. In construction this new motor, which has lately figured in the proceedings and discussions of several of our Mechanics' Institutes, closely resembles the steam-engine; its cylinder and piston, valve-gear, and connections being essentially the same. The principal difference consists in the addition of a compressing-pump and a reservoir, for the purpose of compressing and of retaining a quantity of combustible gases, mixed with a proper proportion of air for its complete combustion, and at a pressure exceeding that which it is proposed to have exerted in the working cylinder. A "jacket" surrounds the cylinder, through which water is kept constantly circulating. The comparatively low temperature thus secured in the walls of the cylinder allows of the employment of the piston with packing rings which has become the standard for the steam-engine, and likewise of the same method of lubrication. A diaphragm similar to that which gives the Davy safety-lamp its security, and composed of several layers of wire-gauze, is placed at the opening through which the gaseous mixture enters the cylinder. This is of more closely woven material than that used in the safety-lamp, and several thicknesses are employed, in order that it may act as an effectual preventive against the communication of ignition to the mass of gas inclosed in the reservoir. A similar diaphragm, but of much smaller area, allows a very small quantity of gas to stream continuously into the cylinder, and as this current is not interrupted by the closing of the induction-valve, its little jet burns constantly, and is always ready to ignite an entering charge. A safety-valve of large area is provided as a precaution against the possible accident of the flames reaching the reservoir.

The burning-gas employed and the air are taken in proper proportions into the compressing-pump, and from this are carried forward, intimately mixed, to the point at which the mixture is to do its work; by this means complete combustion is insured. In the machines of this type in operation at the time of this writing crude petroleum is employed in place of gaseous fuel, and the reservoir is filled simply with air which is carburetted at the point of combustion. It thus becomes possible to operate with but a very minute quantity of liquid in the apparatus at any one time, and an explosion is practically impossible from the fact that the explosive mixture is not formed until it arrives at the combustion chamber.

The induction-valve is protected from the action of the hot gases by the safety diaphragm which is interposed between it and the cylinder. Upon the opening of the induction-valve the mixed gases enter, and are promptly ignited by the constantly burning jet before described. The inventor of this ingenious mechanism claims that the operation of his engine is precisely similar in the action of the engine proper and in the distribution of pressure in its cylinder to that of the steam-engine; that the entering mixed gases burn steadily—not explosively—as they flow into the cylinder; and that the pressure from the commencement of the stroke to the point of cut-off, as proved by indicator diagrams, is as uniform as that observed in any steam-cylinder.

M. TECHNOLOGY.

RECENT PROGRESS IN PHOTOGRAPHY.

The success attending recent experiments in photography seems to justify the expectation of an early revolution in the manipulations of some of its fundamental processes. In the negative process, all the more vexatious and uncertain details have been in a great measure eliminated, and the practice of this branch of photography has been adapted to even the ordinary tourist. The collodion negative process, which displaced the daguerreotype process, about twenty-five years ago, as much by reason of its wider range of applications as because of its comparative simplicity and certainty, has remained essentially the same as when first introduced. Improvements in it have been mainly in the detail, and their adjustment to the various applications of which it was soon found susceptible. Its inconveniences, and the apparently needless complexity of its manipulations, were soon felt, and attempts made to remedy them; but the sensitive collodion film is still produced upon the glass plate by the professional photographer by charging it indirectly with the iodide and bromide of silver, sensitive to light. Some soluble iodides and bromides, insensitive to light, are first introduced into the collodion; and after a film of it has been formed upon the glass, it is rendered sensitive by immersing it in a solution of silver nitrate, where the insoluble haloid salts of silver form in the film, while the nitrates of the other bases, previously combined with the halogens, remain in the solution. But besides the complexity of the manipulations, the silver solution is expensive and voluminous, and requires expensive and fragile receptacles; and, withal, has generally been regarded as the most decided variable in the process, and, directly or indirectly, chargeable with most of its failures. In out-door photography, all the inconveniences and uncertainties attending the use of this solution are multiplied to such an extent that, failing in attempts to eliminate it altogether, the best effort, especially of amateurs, was directed to the improvement of the so-called dry processes, in which plates, prepared up to the sensitive stage, are rendered capable of being kept in that condition by washing them thoroughly with water, then applying some preservative solution, as of tannin, gum, etc., and drying them. Although some of these processes in careful hands have been made to afford very satisfactory results, they are upon the whole inferior to the wet process in rapidity, certainty, and general excellence, in spite of the excessive care and labor required in the preparation and development of the plates. Another plan of relief from the silver solution, which naturally suggested itself at an early day, was the formation of the sensitive silver salts in the collodion, before pouring it upon the glass plate, by introducing into it the silver nitrate and the necessary iodides and bromides. But, after trial, this direct method was regarded for a long time as impracticable, mainly because the iodide and bromide of silver could not be made to form in a sufficiently finely divided condition to remain suspended in the collodion. At last, however, the so-called washed collodion emulsion process has been brought to such a degree of perfection that all the manipulations hitherto found necessary with the baths, washing-trays, preservative solutions, etc., seem to be reduced to the minimum of the one single, simple operation of pouring a sensitive emulsion of the haloid salts of silver with collodion upon the glass plate, and allowing the film to dry. All the articles required are already to be had in the market. The plates thus prepared are said to be of the best quality, of great certainty, and of absolute uniformity, equal in sensitiveness to those prepared by any dry process, and affording a fine film, free from granulation, even under the microscope, and, by regulation of the development, adapted to the production of negatives or positives, as may be desired. Besides the freedom from custom-house annoyances that this process guarantees to the tourist, it renders him at all times, as far as the size of his plates is concerned, entirely independent of the size of the receptacles for the various solutions. The first successful experiments in this direction were made by Bolton and Sayce, two amateurs of Liverpool, about ten years ago. They found that by omitting the iodide, an emulsion of bromide of silver with collodion could be formed, suitable for photographic processes. The conditions most favorable to emulsification have since been most persistently investigated. The first difficulty in the process lay in the inability to introduce the silver nitrate and the bromide employed into the collodion in quantities exactly chemically equivalent; and if the silver nitrate happens to be in excess, fogging the negative results, unless some restraining mineral acid is introduced; while excess of the bromide reduces the sensitiveness of the film to a degree corresponding to that excess, and also exerts a solvent action on the invisible image, unless it is quickly developed. In practice it was found best, therefore, to employ a decided excess of bromide, and then to impart sensitiveness to the film, and prevent any solvent action on the image by washing out the soluble bromide with water. The soluble nitrate of the base, previously combined in the bromide, formed in the film in the operation, although of little consequence in the silver bath in the old process, would also tend to split the film on drying by its crystallization, if allowed to remain in it. All these difficulties were, finally, simply and effectually met by Mr. Bolton by washing out all the crystallizable salts from the emulsion, previously to the formation of a film with it on glass, while a preservative agent was added at the same time. An emulsion was prepared, with only such a degree of care as to the adjustment of the salts that it might give tolerable results, and was then poured into a large flat dish, and the film, when set, was washed several times with small quantities of distilled water, after having been divided into small squares with a silver fruit-knife, until all soluble matter was removed. The very light pellicle, formed by drying the film obtained in this way, contains all the essential ingredients for a sensitive emulsion, seems to keep indefinitely, and only requires simple solution in a mixture of equal parts of alcohol and ether, with the addition of a little alcoholic solution of tannin and of a saturated alcoholic solution of soap, to furnish an emulsion for the preparation of plates for present or future use. Such washed emulsion pellicle, in the form of shreds or powder, can be obtained by mail. The development of a plate is effected by wetting the surface with methylated alcohol and rinsing with water, then treating it with a weak solution of pyrogallic acid for about a minute, and then, whether a feeble picture be visible or not, pouring off the solution into a very dilute solution of ammonia and bromide of cadmium and returning it to the plate, when a vigorous negative image will appear, formed of silver from the reduced bromide. Treatment with dilute nitric acid will convert this into a positive. Many modifications and improvements have been proposed, and are in course of trial. Stillman, in England, and Newton, in this country, have done much in this direction, while Mr. Carey Lea has shown that the presence of iodide of silver is not at all incompatible with a good working emulsion, and doubtless all compounds that were found valuable in the old processes will be found applicable in this. It is not unreasonable, also, to expect that it may be made equal in sensitiveness to the wet process. An emulsion of gelatin and the bromide, as first suggested by Dr. Maddox about the same time that the collodion emulsion was first formed, is far more sensitive than the latter. The removal of the soluble nitrates formed by washing was originated by Mr. King in connection with this process. He placed the gelatin solution, charged with the proper quantities of silver nitrate and potassium bromide, in a dialyser, by which all the crystallizable salts, added in excess or formed in the solution, were removed. The dialyser was found to be entirely unnecessary by Mr. Kennett, who simply poured the gelatin, mixed with the proper salts, into a flat dish, and placed the film in pure water, after it had set but not become dry, until all the crystallizable salts were extracted. The pellicle formed on drying this, cut into shreds, forms the basis of a very sensitive emulsion, and can be transported to all parts of the world in opaque packets. It simply requires the addition of warm water to fit it for use. It is, however, unsuitable for work in warm weather, and the emulsion is liable to putrefaction, so that it must be used soon after its preparation. In the multiplication of impressions upon paper, photographically, from the negative, perhaps no fact has been more annoying to the photographer than the decided liability of the prints to fade and deteriorate. And yet the silver-printing process retains its place almost universally. The carbon process affords equally beautiful and undoubtedly permanent pictures, and is more flexible in its character; but it does not seem, in any of its modifications, to have reached the simplicity and certainty required to entirely supplant the silver process, as it was hoped it would. A process recently proposed by Mr. Willis, however, is full of promise in this respect. In it the salts of platinum are employed, and the results are said to be equal in all respects to those obtained by the silver process, while a far shorter exposure to light is required. It rests upon the fact that ferric oxalate is reduced to ferrous oxalate by the action of light, and upon another fact, discovered by him, that ferrous oxalate is soluble in neutral potassium oxalate, and in this condition instantly precipitates metallic platinum from a solution of its chloride. When, therefore, paper that has been washed with a solution of ferric oxalate and platinic chloride is exposed under a negative to the light, ferrous oxalate is formed in proportion to the action of the light, producing a very feeble image. By drawing the paper then over a solution of potassium oxalate, the ferrous oxalate passes into solution, and reduces the platinum salt in contact with it to a degree corresponding to the action of the light, giving rise to a strong, rich, velvety-black picture, which is perfectly permanent under ordinary influence. The unchanged ferric oxalate is then removed by immersing the print in a weak solution of oxalic acid, and subsequently rinsing it well in pure water.

ETCHING PHOTOGRAPHS ON ZINC, IN RELIEF, FOR ORDINARY PRINTING.

Zinc plates that may be used with the ordinary printing-press may be prepared from ordinary photographic negatives, according to the following process given by Fichtner: A varnish, sensitive to light, is first made by dissolving five parts of Syrian asphaltum in ninety parts of benzol, and adding ten parts of oil of lavender, and then filtering. Much depends on the quality of the asphaltum, and only such pieces as do not melt at 234°, and dissolve with difficulty in oil of turpentine, should be selected. The benzol must be entirely freed by distillation from substances sensitive to light, and must also be entirely free from water. The oils also must be pure, and contain no water. A pure zinc plate coated with this varnish, and allowed to become perfectly dry in a dark room on a level surface, is exposed from twenty-five to thirty minutes in the sunlight under a negative which has been transferred to a gelatin film to prevent inversion of the prints. The invisible image thus formed is developed by pouring upon the plate petroleum, to which one fifth or one sixth its volume of benzol has been added, and keeping the plate in motion and renewing the solvent until the picture appears in the color of the varnish and the lights exhibit the clear metal. The plate is then washed under a stream of water to check the further action of the solvent, and allowed to dry in the light, when the varnish hardens, and acquires the power of resisting the acid employed in etching. The latter process is conducted as usual with dilute nitric acid until deep enough to allow the use of the plate with an ordinary printing-press. —13 *C, January* 1, 66.

NEW PHOTOLITHOGRAPHIC OR AUBELTYPE PROCESS.

It is said that an entirely new and very superior process for multiplying impressions from photographic negatives mechanically has been invented by Aubel, of Cologne, and has been named after him, in order to emphasize its entire independence of all previous processes for a like purpose. If it prove to be all that is claimed for it, it will doubtless increase the applications of photolithography. The use of organic substances, as gelatin and asphaltum, is altogether discarded, and no transferring agent is necessary, the photographic negative being so changed that it permits a transfer to be made to stone at any time in the simplest, cheapest, and most direct manner, with the preservation of all its excellences, while the subsequent lithographic manipulations remain as usual. Ordinary lithographic inks are used in printing, and the operation is much easier than with the usual transfers, since there is no difficulty in keeping open the finest as well as the heaviest hachuring. The stone can also be completely washed with turpentine without injuring the drawing, or affecting the finest tints in the subsequent printing. Among the most decided advantages of the process may be mentioned: 1st, the absence of all necessity for excessive nicety in its details, so that success in the preparation of plates is a rule, want of it the exception; 2d, the freedom from spreading or alteration of the lines of the original; 3d, the possibility of completing the preparation and transfer of a plate to stone in from half an hour to two hours;

4th, the unlimited number of impressions that may be made on any kind of lithographic press, and the avoidance of all necessity for the preservation of designs on stones, since a transfer can be made from the original plate at any time in a few minutes.—34 *C*, V.

THE GILLOTYPE.

A process known as the Gillotype, invented by M. Gillot, for producing printing-blocks by etching on zinc, has been lately introduced very extensively into use in Paris, where it is employed for the illustrations of newspapers and magazines. A paper is first prepared by covering India paper with one or two films of gelatin solution, applied very thinly and evenly, and allowed to dry; after which a coating of cold starch paste is put on, and subsequently a little gamboge dissolved in water. The picture is drawn in fatty ink upon the paper, and laid with its face downward upon the zinc, the surface of which must be well cleaned to remove all grease. A sheet of paper moistened with hydrochloric acid is placed upon it, and above this sheets of dry paper, and the whole passed two or three times through a lithographic press. The back of the paper containing the picture is then to be well moistened with water, which allows it to be removed from the zinc, leaving behind the fatty picture. The plate is then washed with a soft sponge, and subsequently with gum water, to which a little hydrochloric acid has been added, and the whole allowed to dry upon the metal. We now have an ordinary zincograph plate, from which an impression can be taken as from a lithographic stone; but for relief printing etching is required. A fatty or lithographic ink is applied to the plate and allowed to dry; and over the whole surface is then spread, by means of a tuft of cotton, some finely powdered rosin, which attaches to the greasy particles, and imparts to the ink a consistency sufficient to protect the covered parts from the action of the sun. The other portion between the lines and letters is freed from the powder by means of a second tuft of clean cotton, after which the borders and back of the plates are covered with shellac varnish. The plate is then introduced into the etching solution in a kind of trough, which is made to rock back and forward all the time, with the object of washing off continually any salt formed by the acid. The precise details of the operator's manipulation must be managed according to the depth of the etching required. After the operation is alternated several times the plate is finally dried, and the white portions which have not been sufficiently acted upon are cut out with a narrow saw or with a graver, and the block is then ready for relief printing.—18 *A*, XXII., 319.

NEW METHOD OF MICRO-PHOTOGRAPHY FOR MAPS IN WAR TIME.

A system of micro-photography for maps in war time, and applicable also for the use of engineers and others who desire to carry a stock of maps and plans with them in a small compass, has lately been devised by Mr. Baden Pritchard, of the Royal Laboratory at Woolwich.

This method consists in reducing the maps, etc., to a moderate size, and photographing them on sheets of white gelatin. They are then tanned with alum, and washed with collodion and castor-oil. The maximum size of the map is six square inches. Fifty or sixty sheets can be pressed into a space of half an inch in thickness. Officers are instructed to have a collapsible dark chamber, into which, when not in use, the photographs can be slid. They can then be examined like transparent spectroscopic slides. It is proposed to adopt this arrangement at once for the service of the British army.—3 *A*, *June* 24, 1876, 808.

PHOTOGRAPHIC COPYING-PAPER FOR DRAWINGS, ETC.

A very simple French copying-paper affords copies in white lines on a blue ground of drawings pressed in contact with it by means of a glass plate, after ten minutes' exposure to sunlight. The pictures are then fixed by simply washing them in water. According to analyses by Professor Schwarz, the ground consists of Turnbull's blue, formed, doubtless, from the action of ferricyanide of potassium on ferrous oxalate, formed by the reduction of ferric oxalate by the light. He recommends for the preparation of a similar article floating paper on a mixture of 100 cubic centimeters of a solution of 31.7 grammes of red prussiate of potash in 500 cubic centimeters of water, with 300 cubic centimeters of a solution of ferric oxalate, prepared by saturating 9.45 grammes of crystallized oxalic acid with the precipitate formed by ammonia from ferric chloride, and diluting it to 500 cubic centimeters. Exposure to the sunlight under a drawing for a quarter of an hour will afford an impression, which may be fixed by washing it in water.—14 *C*, CCXVIII., 62.

FRENCH METHOD IN ENGRAVING ON WOOD.

A French method in engraving on wood consists in first covering the block with a layer of gelatin (0.39 gramme to 31 grammes of water) by means of a soft brush. When this coating is dry it is covered, in the dark, with a solution prepared of (1) red prussiate of potash, 7.80 grammes; water, 62.20 grammes; (2) ammonio-citrate of iron, 9.10 grammes in 62.20 grammes of water. These solutions are mixed and filtered, and the mixture is kept in the dark. After the layer is dry it is exposed under a negative from ten to twelve minutes, and washed with a soft sponge, when a blue image appears. If thus prepared the coating does not shell off under the graver.—5 *A*, 1875, 98.

RETOUCHING VARNISH FOR NEGATIVES.

It is claimed that a film of the following varnish on negatives, as suggested by Monckhoven, can be retouched with a brush or lead-pencil three or four times as rapidly as one of gum: Add common shellac, in scales, to a saturated aqueous solution of carbonate of ammonia. After twenty-four hours pour off the clear liquid, add about an equal quantity of water, and bring the mixture slowly to boiling, while continually stirring it with a glass rod. A brown shellac solution is thus obtained, and there should be about one hundred parts of water to eight of shellac, and no odor of ammonia. The negative, after being washed, should be flowed with distilled water and allowed to drain, and should then be coated by flowing the varnish over it twice in succession. After drying, the coating is brilliant and hard, and insoluble in water. If many prints are desired, the retouched negative should be varnished as usual.—18 *C*, VI., 461.

PHOTOGRAPHIC POWER OF ARTIFICIAL LIGHT.

Comparative tests of the photographic effect of light from different artificial sources have been made by Riche and Bardy. Plates were sensitized with bromide of silver, and exposed for sixty seconds at a distance of nineteen inches from the light, while screened from its action by ten unequal layers of waxed paper, the first four inches long, covering the whole plate, and each successive layer being one tenth shorter, the last being four tenths of an inch long. The effects were compared by noticing, after development, the number of layers of paper through which the light had acted. Thus it was found that the oxyhydric light penetrated but one layer; the Drummond light, three; that of zinc burned in oxygen, four; of the magnesium light, five; of a jet of nitric oxide passed through a flask containing bisulphide of carbon, six; of a jet of nitric oxide in a vessel of burning bisulphide of carbon, six and seven; of a jet of oxygen in a vessel of bisulphide of carbon, seven; of a jet of oxygen in a vessel of burning sulphur, eight. The introduction of oxygen into a jet of burning sulphur, as it produced the greatest effect upon the bromide of silver, seems to merit further tests as to its practical value.—19 *C*, VIII., 127.

FIRE-PROOF PAPER AND INK FOR VALUABLE DOCUMENTS, ETC.

The fire-proof writing-paper prepared, according to an English patent, of one part vegetable fibre, two parts asbestus, one tenth of a part borax, and two tenths of a part alum, can also be made of a heavier quality, suitable for binding books and preserving manuscripts, etc. The fire-proof ink may be used for printing as well as writing. It is composed of twenty-two drams finely powdered graphite, twelve grains copal varnish, two drams sulphate of iron, and eight drams tincture of gall-nuts and indigo carmine; all well mixed, and boiled in water. Any mineral pigment may be substituted for the graphite to form a colored ink.—9 *C*, XIII., 152.

IMITATION OF JACOBSEN'S COPYING-INK PENCILS.

Imitations of Jacobsen's substitute for ink, in the form of copying-ink pencils, have made their appearance. They consist essentially of the same ingredients as the original, namely, graphite and aniline color, but are consolidated simply by means of tragacanth or other mucilage, instead of by the peculiar process by which the compact, homogeneous mass of the original is formed. The imitation is, therefore, readily distinguished, since it is very porous and brittle, is never pointed, and is generally carelessly finished. The pencils also absorb moisture from the air, and soon become soft and smeary.—6 *C*, 1875, 38.

PREPARATION OF COPYING-INK PENCILS.

According to Viedt, these pencils, or substitutes for ink, can be prepared by making a thick paste of elutriated graphite, finely powdered kaolin, and a very concentrated solution of violet-blue aniline, soluble in water (or of any other aniline color soluble in water), and pressing it, by means of a small press, into sticks about four inches long and 0.1 to 0.15 of an inch thick. When dry they are fit for immediate use. The proper proportions of the ingredients can easily be ascertained by trial; and perhaps gum arabic can be substituted for clay as a cement.—13 *C*, *July* 1, 849.

MARKING-INK UNAFFECTED BY CHLORINE.

An ink for marking linen, etc., which is proof against chlorine, may be prepared, according to Dr. Waltl, by dissolving eight ounces of extract of logwood in water, and adding half an ounce of yellow chromate of potash and a quarter of an ounce of chromate of copper, and evaporating the mass until it begins to thicken, and finally adding half an ounce of varnish.—26 *C*, XI., 14.

INERASIBLE BLACK INK.

A so-called inerasible ink is prepared by Gaffard, of Paris, of one part by weight of lampblack, twelve of potash water-glass, of the consistency of sirup, one of ammonia water, and thirty-eight of distilled water.—6 *C*, XI., 8.

COHAUSEN'S PERIGRAPH.

Tracing the profiles of architectural objects, by obtaining the co-ordinates of different points, rests so much upon the delicacy of touch and sight of the individual that the results are not accurate. A very simple instrument, devised by Cohausen and named a perigraph, eliminates this personal source of error by rendering the operation a purely mechanical one. It consists essentially of a lever, moving and sliding in such a way on a pivot, on a board covered with drawing-paper, that, when the board is held by the left hand from a ladder, near to the object to be traced, and the one end of the lever is moved by the right hand so that the other end continually touches the object, a pencil fixed in the lever will trace a diminished profile of the object on paper. This can afterward be enlarged to the full size by means of the same instrument.—14 *C*, CCXVI, 204.

A PRINTER'S INK READILY REMOVABLE FROM WASTE PAPER.

The following process for the preparation of a printer's ink that can be far more readily removed from waste paper than ordinary printer's ink has been patented by Kirscher & Ebner. Iron is dissolved in some acid—sulphuric, hydrochloric, acetic, etc., will answer—and half of the solution is oxidized with nitric acid and added to the other half, and the oxide precipitated from the mixture by means of soda or potash. The precipitate is thoroughly washed and treated with equal parts of solutions of tannic and gallic acids, and the bluish-black or pure black pigment formed is thoroughly washed and dried and mixed with linseed-oil varnish, and can then be immediately used for printing from type, copper, wood, steel, or stone. Waste paper printed with it can be bleached by digesting it for twenty-four hours in a lukewarm bath of pure water and ten per cent. of caustic potash or soda, and then grinding it well in the rag-engine, and throwing the pulp upon cloth and allowing it to drain. It is then to be washed with pure water containing ten per cent. of hydrochloric, acetic, or oxalic acid, or of binoxalate of potassa, and allowed to digest for twenty-four hours, and may then be worked up into paper, or it can be dried, and used as a substitute in the manufacture of finer paper.—5 *C*, XXXIX., 1875, 312.

FOR TAKING TRACINGS.

The following process has lately been suggested: One part by volume of castor-oil should be dissolved in two or three volumes of alcohol, and this solution applied to the paper with a brush. The spirit soon evaporates, leaving the paper transparent and ready for use. A tracing in pencil may then readily be made, and when finished the paper is immersed in alcohol, which dissolves out the oil, restoring the sheet to its original condition. The drawing may afterward be completed in Indian ink or in colors.

COPYING APPARATUS OF BAUER & CO.

A copying apparatus, manufactured by Bauer & Co., of Vienna, consists of a metallic tablet framed in wood, and covered with a paste containing aniline violet, or red. By tracing with a pencil or style on paper laid upon this, enough of the material will be taken up by it to yield copies on moistened paper, by laying the latter on it and patting it with the hand. The results, however, are very limited in quantity and quality, since the paper is not strong enough to yield even fifty copies.—6 *C*, *January* 20, 1876, 28.

PAPIER-MACHÉ ORNAMENTS, ETC.

Some English *papier-maché* articles are remarkable not only for their form and general appearance, but also for their durability. They are manufactured by first pressing a sheet of very porous but strong paper, manufactured expressly for the purpose, upon the metal greased with tallow. This is then coated with good flour paste and a second sheet is laid on, and pressed and rubbed until it takes the form of the model and adheres firmly. The whole is then placed in a drying-chamber at about 104°, and then the operations of laying on and drying are repeated until the desired thickness is produced—twenty to forty sheets being frequently required for the purpose. The form is then removed, all the sides are carefully adjusted, and the article is then hardened by first immersing it in linseed-oil and purified wood-tar, and coating six to eight times with varnish, allowing it to dry thoroughly after each coat. It is finally ground down with pumice-stone, and ornamented with bronze, gold, or mother-of-pearl. Cheaper articles are manufactured from a species of paper pulp with certain proportions of white-lead, rosin, linseed-oil, and sugar of lead, carefully kneaded and rolled by the aid of steam. This is then pressed into moulds and dried. The most ordinary articles are made of pulp and earth colors, with the addition of some hardening cement.—5 *C*, L., 400.

PRESERVATION OF PLASTER CASTS.

Mr. John Bell communicates to the Society of Arts the statement that the thorough saturation of plaster in melted paraffin will effectually preserve it from deterioration by the action of the weather. The paraffin, it is said, hardens the plaster so much that the finger-nail will scarcely scratch it, increases its weight considerably, gives it an appearance of transparency like ivory, and preserves it though subjected to repeated washings. The process of saturation is stated to be similar to that employed in the saturation of plaster casts in stearin.

IMPROVEMENT IN PLASTER OF PARIS.

A new process of manufacturing plaster of Paris is announced, which is said to afford excellent casts, that set slowly, and are of a pure white color. The process consists briefly in immersing the unburnt gypsum for fifteen minutes in water containing ten per cent. of sulphuric acid, after which it is calcined.

WATER-PROOF DRESSING FOR LEATHER.

A dressing for rendering leather water-proof, made as follows, as proposed by Hager, has been found to answer the purpose: Soften one part of India rubber in five parts of illuminating petroleum, by digestion for a day, and add twenty parts of paraffin to the pasty mass, and digest again for half a day, with repeated stirring, and then mix it with five parts of oil and five of tallow, and finally add ten of petroleum, or enough to give the mass the consistency of butter.—8 *C, February* 11, 1875, 55.

EFFECT OF FREEZING UPON THE COLOR OF FABRICS.

The reduction of the color of indigo blue on cotton by freezing, noticed by Köchlin, is ascribed by Goppelsröder to ozone in the air, which, he found by experiments, acts at temperatures below the freezing-point, if the material is not dry. He found that cochineal red on wool was decidedly weakened, but not bleached, after a week's exposure to ozone; aniline black remained unchanged; aniline brown on cotton became yellowish-orange; fuchsin, aniline blue and violet, corallin, and iodine green were bleached, as well as dyewood lakes, and even Turkey red. Ozone is also very effective in developing certain colors. This action is very decided in the case of aniline black, which is developed by it in from one to one and a half hours. The Gramme machine is suggested for the production of ozone.—24 *C*, XV., 113.

WATER-PROOFING FABRICS WITH BICHROMATED GELATIN.

In cases where a certain degree of stiffness is not objectionable, as in the manufacture of canvas trunks, knapsacks, etc., and possibly also of roofing-paper, the material may be easily and cheaply rendered water-proof by simply stretching it in a frame, and coating it several times with a hot five to ten per cent. solution of gelatin, to which one part of bichromate of potash has been added in solution for every five of gelatin, and then exposing it to sunlight, or diffused daylight.—13 *C*, *December* 15, 1875, 1560.

DYEING PARCHMENT PAPER WITH ANILINE COLORS.

So-called vegetable parchment can, like silk and wool, be combined directly with aniline dye-stuffs without a mordant, and in this way a very durable material, of a variety of colors, may be prepared, suitable for book-bindings, fancy boxes, cases, etc.—5 *C*, XXXII., 1875, 256.

DISCHARGING ANILINE BLACK FROM FABRICS.

In order to discharge black from fabrics dyed with aniline black, Witz treats the portion with an acidified solution of permanganate of potash, whereby peroxide of manganese is precipitated in the fibres. A solution of oxalic acid is then used, which removes the peroxide, and leaves the parts of the cloth acted on perfectly white. It is suggested that a solution of the permanganate, thickened with infusorial earth, could be printed on fabrics, and thus discharge white figures on an aniline-black ground.—6 *C*, *January* 21, 1875, 29.

ARTIFICIAL ULTRAMARINE INDUSTRY.

The total production of artificial ultramarine during the year 1874 was 150,000 cwt., of the value of $3,000,000. The manufacture is chiefly confined to Germany and France, the former country exporting annually about 60,000 cwt. In addition to the greenish-blue, pure blue, and violet-blue shades, a violet ultramarine was among the exhibits of the Vienna Exposition. The composition and mode of preparation of this new product are as yet unknown.—*Manuf. Review*, VIII., 18.

PROHIBITION OF ARTIFICIAL ALIZARINE IN RUSSIA.

By a recently issued Imperial Ukase, the importation of artificial alizarine into the Russian Empire is prohibited. The purpose of this prohibition is said to be the protection of the cultivators of the Russian madder (marena), who for the last twenty years have been extensively engaged in its culture in the province of Daghestan. A few years ago the value of the crop was estimated to have an annual value of three millions of rubles, but it has now greatly fallen off. The aniline colors are, curiously enough, included under the prohibition—with the single exception of crystallized magenta—which is the one most extensively contaminated with arsenic.—*Manuf. Review*, VIII., 18.

GOLDEN-OLIVE ON CLOTH.

For two pieces of cloth—sixty-one pounds—dissolve four pounds of alum and two pounds of purified argol in a decoction of thirty pounds of fustic; add four pounds of turmeric and two pounds of orchil, turn the fabric in, boil for an hour, and then bring to the desired shade with sulphate of indigo, and further boiling.—23 *C, August* 27, 1875, 631.

DYEING SILK.

The following processes are recommended by Reimann's *Färber-Zeitung* for dyeing silk. First remove the gum, except from tram, best by moving the silk about, suspended on sticks, in a bath heated to boiling, containing one quarter of a pound of soap for each pound of silk; allow it to remain in this for twenty minutes, and repeat the operation in a bath containing one fifth of a pound of soap for each pound of silk. Tram must retain its gum, in order that the fabrics made with it may have the necessary stiffness and body; to prepare it for dyeing, place it, until its yellow color disappears, in a bath, at a temperature of 212°, prepared by mixing equal parts of sulphuric, hydrochloric, and nitric acids, and adding water enough to bring it up to 30° Baumé. For light shades then wash and bleach it; for dark shades the bleaching is unnecessary. Treat subsequently in the same manner as ungummed silk. In dyeing brown, place the silk, before ungumming it, in a tin composition of 32° Baumé, rinse it, on removal from this, three times, ungum it, and dye in a fresh bath of alum, indigo carmine, fustic, and logwood, according to the shade desired.—24 *C*, XXXIII., 1875, 260.

BEAUTIFUL BLACK FOR STRAW HATS, ETC.

The following process, which is said to afford a beautiful and durable black on straw hats, can be readily applied, if desired, with but little trouble or loss of time by cloth dyers: The hats are first placed for several hours in a moderately strong soda or lye bath, and, after rinsing from it, are steeped overnight in an old sumac or gall bath. On removal from this, they are allowed to drain off well, and placed for two or three hours in a pyrolignate of iron bath. They are then exposed to the air for some time, when they almost blacken, and rinsed, and dyed up lukewarm with logwood, and drawn through a weak solution of glue, and dried and brushed.—5 *C*, XXXIX., 1875, 312.

DYEING BLACK WITH CERIUM SALTS.

Professor Böttger calls the attention of the Physical Society of Frankfort to the recent introduction of the bisulphate of cerium in dyeing, especially to the production with it, in connection with chloride of aniline, of an intense deep black on cotton yarns and fabrics. He found that by dipping the yarn several times, alternately, in a solution of chloride of aniline, slightly acidified with hydrochloric acid, and in a solution of bisulphate of cerium, and finally in a solution of bichromate of potash, it acquired a remarkably beautiful black color.—5 *C*, XXXVII., 1875, 295.

NEW BLACK FOR WOOL.

Wool dyed black according to the following recipe, it is said, does not rub off in the least, while the fibres remain loose and open, and it has a desirable reddish cast. Boil the thoroughly washed wool well for an hour and a half in a bath composed, for one hundred pounds of wool, of two and a half pounds of chromate of potash, two and a half pounds of alum, one half pound of blue vitriol, and two pounds of commercial sulphuric acid, and dye it, without rinsing in fresh water, with twenty pounds of logwood and twenty pounds of Brazil-wood. It is advantageous for the color to allow the wool to remain in the mordant for twelve hours.—5 *C*, XXXII., 1875, 256.

XYLINDEIN, A NEW DYE-STUFF.

The name *xylindein* has been given to a green dye-stuff, examined by Fordos and Rommier, which results as a pathological effect of *Peziza æruginosa* in dyeing wood of the beech, oak, and birch, often to such an extent as to impart a dark blue-green appearance to large blocks. This coloring matter has been extracted from the green-colored wood, by Liebermann, with carbolic acid, and has been precipitated from the dark-green solution in dark-green flakes, by the addition of alcohol or ether. By recrystallization from the solution in carbolic acid it was obtained in small four-sided crystals, of a high coppery lustre. These are insoluble in most solvents, except in concentrated sulphuric acid, with a grass-green color, and in carbolic acid and aniline, with a beautiful dark-green color. No formula can as yet be given for it.—1 *C*, IV., 1875, 64.

EOSIN, A NEW FLUORESCENT DYE-STUFF.

A new dye-stuff has been introduced into the market under the name of *eosin*, by a German company. It is characterized, in solution or upon silk, by a beautiful fluorescence, combining in a most decided manner beautiful rose and reddish-brown tints. It consists of glistening greenish scales, readily soluble in water, and of an alkaline compound of a yellow dye-stuff, precipitable by acids. It seems related to the Bavarian phthalic acid dye-stuffs. Meister, of Zurich, employs it instead of litmus in the rapid titration of alkalies, since the disappearance of its beautiful rose color, upon acidification, is much more marked and sudden than the change of the blue of litmus.—8 *C*, *January* 7, 1875, 11.

A NEW ANILINE RED.

Dr. Isidor Walz has called attention to the discovery of a new coal-tar color which promises to become of importance. It yields shades exactly like those of cochineal, and almost as fast. A sample of wool dyed with it was scarcely affected by a week's exposure to the sun. The discoverer is a New York chemist.—*Manuf. Review, N. Y.*

GEORGINE, A NEW YELLOW DYE.

A new yellow dye has been named Georgine, by Singer, of Tournay. It is said to be easily fixed upon all kinds of fibres, needing no mordant with silk and wool, but with cotton requiring previous treatment with alum, or passage through a cold or lukewarm sumac bath. For printing upon wool, cotton, or half-wool, it is thickened with gum water. It may also be employed to bring out the colors of turmeric, fustic, and picric acid, and affords mixed colors of remarkable purity, with other dye-stuffs.—26 *C*, XI., 14.

BARYTA-GREEN.

Böttger recommends the following mode for the preparation of baryta-green: Add gradually two parts of finely sifted peroxide of manganese to a mixture of two parts of caustic potash and one part of chlorate of potash in a state of fusion, and finally heat the mass to a low red heat. Allow it to cool, powder it, pour cold water over it, filter, and add to the green filtrate, in the cold, a solution of nitrate of baryta. Wash well with water the beautiful violet neutral manganate of baryta that separates, and when dry mix with it from one half to one part of hydrate of baryta, and heat the mixture at a low red heat, in a rather shallow brass or copper vessel, with continued stirring, until the contents, upon cooling, manifest a pure green color. Finally, pulverize it thoroughly, and treat repeatedly with cold water, in order to remove any hydrate of baryta present.—20 *A*, *March* 27, 338.

DYEING COTTON PURE BLUE.

The following is suggested by Böttger for dyeing cotton a pure blue. Heat a mixture of 137 grains of Paris blue, 137 grains of tartaric acid, one half a fluid ounce of ammonia water, and two and a half fluid ounces of water, and filter, after cooling. Add to the deep blue filtrate a solution of caustic soda until it is decolorized, and after some time assumes a light yellow tint. Impregnate the cotton with this solution, and pass it (best after allowing it to dry) through a warm, very dilute solution of sulphuric acid, and it will immediately assume a beautiful blue color, and needs only to be washed in water. The sulphuric acid may be so diluted that it has scarcely a perceptible sour taste.—5 *C*, XL., 32.

FIXING PRUSSIAN BLUE ON FABRICS.

Scheurer, of Berlin, recommends for a dark shade fifty parts of tartaric acid, one hundred and ninety parts of ammonia, one hundred and ten parts of dry powdered Prussian blue, and one hundred and fifty parts of water, with the employment of a gentle heat to hasten solution. In dyeing, the material is passed through this solution, and then, after drying, through an acid. For printing, an equal weight of thick tragacanth water is added to it, and the material, after printing and drying, is also passed through an acid. After the dyeing, or printing, a very deep violet color develops in drying, which immediately changes to blue on contact with the acid, and is almost completely fixed, remarkably little being lost in washing.—25 *C*, XXIV., 7.

FORMATION OF PURPURINE FROM ALIZARINE.

Lalande has succeeded in preparing purpurine from alizarine, which was perfectly free from the latter, after treating it with oxidizing agents under different conditions. One part of dry pulverized alizarine, and one of dry arsenic acid, or of peroxide of manganese, were added to eight to ten parts of concentrated sulphuric acid, and the temperature was gradually raised to 302° to 320°, until a drop of the mixture placed in slightly alkaline water produced the red coloration of purpurine. The mass was then treated with a large quantity of water and the precipitate washed with cold water, dissolved in a sufficient quantity of a saturated solution of alum, and re-precipitated by an acid. It was completely purified by treatment with alum again and crystallization out of superheated water.—5 *C*, XL., 23.

DOVE-COLOR ON RAW WOOL.

For one hundred pounds of wool, dissolve two pounds of alum and one pound of argol in a hot bath, and cool to 158°;

and, after the addition of a decoction of two pounds of logwood and five ounces of indigo carmine, enter the wool, and heat to boiling.—23 *C*, VII., 631.

VARNISH FOR BLACKBOARDS.

The following is the recipe, according to the patent of Formhals (which has expired), for a coating for blackboards: Alcohol, 95 per cent., 65 parts, or alcohol, 90 per cent., 67 parts; bleached shellac, 8 parts; Paris black, 8 parts; levigated pumice-stone, 4 parts; Paris blue, half a part; burnt umber, 4 parts; dryer, 8 parts. The pigments and pumice-stone are carefully mixed with alcohol, the shellac in solution being added last.—6 *C*, 1875, 18.

RENDERING OAK WOOD A BEAUTIFUL ORANGE-YELLOW.

Melt together, with continued stirring, one pint of oil of turpentine, and about 1200 grains of tallow, and 300 of wax. Rub the wood, in a warm room, with the mixture until a dead lustre is produced, and coat it an hour afterward with thin French polish. Greater brilliancy and a deeper tone may be produced by an additional coat of polish.—26 *C*, XI., 127.

BROWN STAIN FOR OAK.

Welger recommends the following as affording a cheap coating for wood, and which is very adherent, even when exposed to the weather: Brush the wood with a solution of persulphate of iron of 2° to 2½° Baumé. The bluish-gray tint it acquires on drying changes to an agreeable light-brown shade with linseed-oil varnish. A solution of protosulphate of iron will answer as well as one of persulphate. A dark brown shade may be imparted by subsequent coating with a half per cent. solution of permanganate of potash, and then with linseed-oil.—19 *C*, VIII., 26.

DEEP WALNUT STAIN FOR LIGHT WOODS.

The employment of alkaline manganates for staining light woods in furniture and floors a beautiful, uniform, and durable walnut brown is highly recommended by Viedt. The action depends upon the decomposition of the salt in the pores of the wood, with the separation in them of very finely divided brown hydrated peroxide of manganese. In practice, addition of magnesium sulphate to the solution hastens the reaction. The process may be conducted as follows: Dissolve equal parts of manganate of soda and crystallized Epsom salt in twenty to thirty times the amount of water, at about 144°, and brush the planed wood with the solution. The less the water employed, the darker the stain, and the hotter the solution, the deeper it will penetrate. When thoroughly dry, and after the operation has been repeated, if necessary, the furniture is smoothed with oil, and finally polished. It is well to wash it carefully with hot water before smoothing, to prevent the efflorescence of the sulphate of soda formed. For floors the solution may be employed boiling hot, and if the stain is not dark enough, a second application of a less concentrated solution should be made. After it is quite dry, it should be varnished with a perfectly colorless oil varnish. On account of the depth of penetration of the stain, a fresh application will not soon be required. —25 *C*, XLII., 331.

GOLD VARNISH FOR METALS.

Dr. Kaylor found picric acid and boracic acid in a gold varnish for metals, which afforded a very hard and beautiful surface, and he recommends a clear solution of shellac, with the addition of picric acid, and about half of one per cent. of boracic acid, as giving results equally good.—8 *C*, XII., 311.

GILDING LETTERS AND DESIGNS ON GLASS.

According to Möser, the glass, after being thoroughly cleaned with powdered chalk, is coated uniformly, by means of a brush, with a hot solution formed by soaking seventy-five grains of gelatin in one quart of water, and then boiling it. The gold-leaf is next laid on very evenly, an operation requiring some practice. After this coating is dry, additional layers of gold-leaf are placed on it by means of the gelatin solution. False leaf may also be used for the purpose. The less uniform and heavy the leaf, the greater the number of layers required. When the gilding appears perfectly opaque, on being held up to the light, and has become quite dry, the letters or designs, previously traced with the point of a needle if desired, are painted, reversed, upon it with black japan. If the layer of gold is too thin the varnish may be visible through it, and mar the effect. When the varnish is thoroughly dry, the excess of gilding is softened with water, and washed off, while the designs protected by it remain, and exhibit a very fine lustre, if the manipulation has been careful. Usually the whole glass is then blacked up with a dark oil-color, which renders the letters more distinct, protects them, and reduces the disturbing effect of reflection.—14 *C*, CCXVI., 184.

PURIFICATION OF FIXED VEGETABLE OILS.

Fixed vegetable oils are purified much more perfectly and cheaply than usual by a process practiced in England, in which the agitation of the oil, during purification, is accomplished by a current of air forced into it through a system of perforated tubes entering the bottom of the vessel, instead of by means of revolving paddles. The sulphuric acid is added to the oil, as usual, cautiously during the agitation, and on account of its more thorough contact with the oil effected by this method, the carbonization of the albuminous and other impurities is more complete. The acid is removed from the purified oil, as usual, and any residue of water by means of steam heat.—5 *C*, XL., 396.

OIL-PAINT FOR FLOORS.

None but earth-colors should be used in painting floors, and the rapid wearing off of a coating of oil-paint on a floor is a sure indication that white-lead has been mixed with the paint. This is generally the case, since it causes the paint to cover better and spread easier. Even the employment of a varnish that has been boiled with litharge should be avoided, and one boiled with borate of manganese preferred. It is also very important that the first coating should be perfectly dry before a second is laid on.—5 *C*, XL., 23.

PALMIERI'S DRAGOMETER.

Professor Palmieri has constructed an instrument which he calls a "dragometer." It is intended to determine the character of oils and textures by means of electricity. Among the properties claimed for it are: 1. It will show the quality of olive-oil. 2. It will distinguish olive-oil from seed-oil. 3. It will indicate whether olive-oil, although of the best appearance, has been mixed with seed-oil. 4. It will show the quality of seed-oils. 5. Finally, it will indicate the presence of cotton in silken or woolen textures.—12 *A*, *Sept.* 9, 427.

UTILIZATION OF THE SUDS FROM THE WASHING OF WOOL.

In nothing has the advance of practical science been more clearly evidenced than in the extent to which substances formerly wasted and lost are now reclaimed and made to constitute an important element in the profits of the manufacturer. One of these applications consists in the recovery of the soap-suds from the washings of wool in woolen factories. These were formerly allowed to run down the sewers and into the streams, to the great pollution of the latter; but in Bradford, England, they are now run from the washing-bowls into vats, and there treated with sulphuric acid. The fats rise to the surface in a mass of grease a foot or more in thickness, which is carefully collected and treated in various ways, mostly by distillation. The products are grease, used for lubricating the cogs of driving-wheels in the mills; oleic acid, which is worth about $160 per ton, and used as a substitute for olive-oil; stearin, worth $400 per ton, etc. It is said that some large mill-owners are now paid from $2500 to $5000 a year for these suds, which a few years ago were allowed to run to waste.—18 *A*, XXI., 8.

STEEL BRUSHES FOR CLEANING IRON CASTINGS.

The removal of sand, etc., adhering from the moulds to iron castings, generally accomplished by filing, is said to be effected far better by means of steel brushes, placed in the market by Berthold, of Dresden. They are made of thin strips of steel, in the form of ordinary scrubbers, and also in that of whitewash brushes, and are reported to remain sharp for a long time, and to be far more convenient in use than the file. —9 *C*, XIII., 106.

APPARATINE, A SUBSTITUTE FOR GUM, STARCH, ETC.

Gerard has introduced a substitute for gum, starch, gelatin, etc., for finishing all kinds of fabrics of cotton, wool, or silk, and also for thickening in calico-printing, which he names apparatine. It is said to afford very superior effects, and to impart a hitherto unattainable velvety surface, and to render transparent articles as stiff as metallic foil. It is prepared by stirring vigorously 16 parts of potato starch into 76 parts of water, and then adding, with continued stirring, 8 parts of potash or soda lye of 25°. After a few minutes the liquid clears up and forms a gelatinous mass, which is well beaten up, the quality of the apparatine being dependent on the amount of beating. It simply dries in the air without decomposition or spoiling, and without acquiring any odor, and may be formed into thin, transparent, colorless sheets resembling horn, but more flexible.—13 *C*, *May* 1, 1875, 576.

CLARIFYING AN ALCOHOLIC SOLUTION OF SHELLAC.

Peltz found that after shaking thoroughly one part of petroleum naphtha with three parts of an alcoholic solution of shellac, the liquid separated, on standing a few minutes, into an upper layer of naphtha containing the wax in the shellac, and a lower one of clear solution of shellac with but little adhering naphtha. With a solution of shellac in ninety-five per cent. alcohol the two layers will form, as above, only after the addition of water, so that alcohol below ninety per cent. is preferable to one above it for dissolving the shellac. A solution, clarified as above, however, leaves a more brittle and less adhesive film on evaporation. This defect may be remedied by the addition of one to three per cent. of Venetian turpentine. Benzine may be substituted for the petroleum naphtha with like results.—3 *B*, *March* 11, 369.

USES OF GELATINOUS HYDRATED PHOSPHATE OF LIME.

Dr. Sacc has published a memoir upon the industrial applications of gelatinous hydrated phosphate of lime, which, according to his account, precipitates coloring matter, such as a decoction of powdered cochineal, in the condition of a lac; as also the metallic oxides—among others that of copper. Its affinity for coloring matter is, if any thing, even greater than that of albumen, which it can readily replace in various fabrics. For this preparation it is only necessary to introduce the tissue in a solution of phosphate of lime and a more or less dilute hydrochloric acid; then to wring out the cloths and place them in an alkaline color bath.—3 *B*, XXXVI., 374.

SCHWEITZER'S SOLVENT FOR CELLULOSE.

Professor C. Neubauer recommends the following method for obtaining the well-known cupro-ammonium solution for technical use. He prepares an oxide of copper by the precipitation of sulphate of copper solution with caustic soda, in presence of sal ammoniac. The resulting precipitate is thoroughly washed with water, first by decantation and then upon a filter, after which it is preserved under water. To prepare the cupro-ammonium solution the oxide above referred to, after thorough agitation with the water, is slowly added to a quantity of ammonia contained in another vessel. The addition of oxide is to be continued so long as the same is dissolved by the ammonia. The resulting deep-blue colored solution dissolves cotton-wool at once, and in considerable quantity.—*Fresenius' Zeit. für Anal. Chem.*, XIV., 195.

OLEIC ACID AS A SOLVENT AND TEST FOR GUM COPAL.

A very small quantity of oleic acid dropped upon a sample of gum copal, and but gently warmed, will dissolve that gum completely. It is also an excellent reagent for distinguishing true amber from its imitation in copal.—9 *C*, XIII., 25.

ADULTERATION OF BEESWAX WITH PARAFFIN.

To detect this very common form of adulteration, Miller recommends that a small quantity of the suspected substance be tested to about 325° Fahr. with concentrated sulphuric acid, and upon cooling, the paraffin, if it be present, will be found upon the surface of the mixture.—*Fresenius' Zeit. für Anal. Chem.*, XIV., 200.

BLEACHED ISINGLASS.

On account of the preference shown by consumers generally for thin white isinglass, the inferior dark and bloody samples are bleached chemically at St. Petersburg, and sold as of first quality, although they have naturally a yellowish cast. According to Kattus, it has been established by experience that the bleaching impairs its adhesiveness and clarifying power; and since the bleaching agent is never entirely removed, it may also very easily affect wine injuriously when used for clarifying it, and it may prove even more objectionable for medicinal and culinary purposes, although preferred to the natural isinglass on account of its color. Besides, only bleached isinglass can be adulterated with gelatin, and recently an impure article of this kind has been largely manufactured, which can scarcely be distinguished from the bleached and but slightly opalescent genuine article, while the Astrachan isinglass, even when soiled or dark and bloody, is fully as effective as the bleached. The chief characteristics of the genuine article are its freshness of appearance and peculiar opalescence.—5 *C*, XL., 214.

BLEACHING SPONGES.

Sponges are said to be bleached by the following process, without the emission of injurious or unpleasant gases: They are first covered with hydrochloric acid, for the removal of calcareous matter, and, after being washed with water, are immersed for five or ten minutes in a solution of one part of potassium or sodium permanganate to forty-five of water, in which they acquire a dark-brown color, which disappears on immersing them for one or two minutes in a solution of one part of oxalic acid in fifty parts of water, with the addition of a little sulphuric acid. They are then thoroughly washed with water. The brown color acquired may also be removed without injury by repeated immersions for several minutes in very dilute sulphuric acid.—13 *C*, *November* 1, 1867.

UTILIZATION OF CHROME-ALUM.

Although the chrome-alum occurring as a refuse product in the manufacture of certain coal-tar colors is reconverted in some cases, by Strohmeyer's process, into bichromate, in many cases it is entirely disregarded, owing to the tediousness and expensiveness of that method. A new way has recently been devised, which, it is claimed, does not require evaporation of the original refuse liquid, permits the almost complete recovery of the agent employed, and furnishes a liquid ready for immediate use. The product is said to amount to twenty-three and a half per cent. of the chrome-alum, so that the process may even be found profitable, aside from its use in connection with the manufacture of aniline and alizarine.—8 *C*, XII., 254.

MODIFICATIONS OF CHROME-ALUM.

Gernez states, as the result of experiments, that solutions of chrome-alum which have been converted into the green modification by heating to 212° never crystallize, even if supersaturated, if care is taken that not a trace of violet chrome-alum or any other alum is present, and also that they retain their green color, and it is never assumed by solutions prepared cold. Upon slow evaporation a green transparent mass is left, which gradually fills with cracks. If, however, a fragment of crystallized chrome-alum, or other alum, is introduced into the above solution, crystallization instantly begins, and gradually violet chrome-alum crystallizes out.—15 *C*, XXX., 48.

REMOVING VEGETABLE SUBSTANCES FROM WOOL.

Messrs. Barral and Salvetat, in a memorial presented to the Academy of Sciences of Paris, refer to the fact that a large proportion of the wool imported from Australia and South America contains a greater or less percentage of vegetable matter mixed with it, which, of course, is injurious to its quality, and which usually resists the mechanical means of separation. An important problem, therefore, has been the destruction and elimination of the vegetable fibre by agencies that do not affect the wool. In summing up the results of their experiments, and considering those of others working in the same field, Barral and Salvetat remark that the cellulose and woody fibre can be decomposed under the action of several chemical agents, provided that the tissue, dried in the air after soaking, is then raised in a stove to a temperature of about 350° Fahr. These agencies are sulphuric acid, hydrochlorate of alumina, hydrochloric acid, nitric acid, chlorides of zinc, of iron, of tin, and of copper; nitrates of copper, of magnesia, and of iron; sulphates of tin and of alumina, etc.

PROCESS FOR COVERING COTTON WITH SILK.

A patent for effecting this object has been granted to A. Müller, the details of which are stated as follows: He makes a solution of silk in hydrochloric acid (or ammoniacal solution of nickel or copper). The solution is filtered through sand, diluted until it begins to cloud, and the cotton (previously mordanted) is immersed in it for two or three minutes, then removed and washed. In this manner a silk-coated cotton fabric is produced.

NEW METHOD OF FULLING WOOLEN GOODS.

The following method, employed in Elbeuf, is said to require but a few hours, and to leave the wool very soft, while it does not attack the color. It consists in simply replacing the fuller's earth by suint. The latter is obtained as follows: A wooden vessel is filled with raw, unscoured wool, on which water is pumped from another vessel, and allowed to remain upon it three hours. It is then all pumped back into the second vessel, and again over the wool in the first vessel, and allowed to remain on it two hours. The operation is repeated several times, according to the quantity of suint in the wool, and the latter is then removed and thoroughly freed from water, and a fresh portion of wool introduced and treated in a similar manner, until the water is sufficiently saturated with suint, when it is drawn off and preserved for use. The cloth fulled with the necessary quantity of this liquid, in the machine, and then thoroughly washed, is said to be found perfect.

THE HAIR OF SQUIRRELS' TAILS FOR BRUSHES.

A useful hint in regard to the utilization of squirrels' tails was contained in the Chicago *Field*, in the form of an extract of a letter written by Mills Brothers, manufacturers of brushes, in Brooklyn, N. Y., to *The Commercial* of California. They state a fact which is perhaps known to few of our readers, that the so-called camels'-hair brushes are made from the hair of the tails of squirrels, the demand for which is increasing very rapidly. It is a question, however, whether the tails of the California squirrels—animals extremely destructive to the crops in California—will answer the purpose, as they are not true squirrels, but a spermaphile, or ground squirrel. The hairs on the tail of this animal, although long, are coarser than those of the tree squirrel, and probably less desirable. There would, however, be no difficulty in obtaining a sufficient supply of the tree squirrels, such as the red, the gray, the fox squirrel, etc., throughout the various parts of the country, to meet a very large demand.—*Chicago Field.*

NUMBERING SILK THREAD AND FABRICS.

The system of numbering yarns by giving the number of meters in a gramme, agreed upon by the International Congress assembled at Vienna during the Exposition, is not satisfactory for silk threads, which are not, properly speaking, spun, but result rather from the simple combination of threads already formed. While the numbers of spun yarn may therefore be accurately expressed by the differences in length of a given weight of yarn, unvarying practice indicates that, for silk, it is preferable to employ the variations in weight of a given length of yarn, although the numbering on this plan begins with the finest instead of with the coarsest threads, as in the former case. Besides, the numbers for silk on the new plan would be inconveniently large. The original basis for the numeration of silk was the number of deniers (twenty-fourths of the old French pound) in 9600 ells; and afterward, on account of convenience and economy of time, the number of grains (twenty-fourths of a denier) in 400 ells, the name denier being retained; but it was found to vary greatly in different countries on account of the difference in the value of the grain; and even after changes in 1856 in France and Italy, the basis in France was 500 meters and 0.05311 gramme; in Italy and Switzerland, 450 meters and 0.050 gramme; and in Germany 476 meters and 0.05336 gramme. A basis of 500 meters and one half of a decigramme, suggested by the Chamber of Commerce of Crefield in 1874, was presented to the Congress at Brussels. While the exceptional character of silk in a system of numbering was recognized by that body, a desire was manifested to render the metrical character of its basis more apparent, and to give it a simpler relation to that of the others by making the units 1000 meters and one decigramme, in which case No. 1 of silk would correspond to 100,000, and No. 20 to 1000 of the other system. To this it was objected that, however desirable such a basis might seem theoretically, it was questionable on practicable grounds; since, from the nature of silk, it is impossible to produce threads of as great uniformity as spun ones, differences as high as thirty-five per cent., and even higher, having been determined in a single thread of Asiatic silk, which differences are less manifest when long threads are taken, while the costliness of the material and the uniformity required in the woven fabric render it very desirable to the manufacturer to possess as accurate knowledge as possible of short lengths. Besides, comparison with the other system could readily be made by doubling the numbers in that suggested. The Congress, therefore, finally unanimously agreed, 1st, that the numbering of twisted and untwisted silk, as of other textile materials, should be based on metric and decimal measures and weights, with 1000 meters as the unit of length, and 1 decigramme as the unit of weight; 2d, that as the scale of numbering the variable weight of a uniform length shall be taken, and that 500 meters shall be weighed with a weight of 0.05 gramme as unit. These recommendations have been adopted at Lyons and Turin, and will doubtless be universally accepted.—6 *C, June* 3, 1875, 214.

CUIR-LIÈGE; A NEW FABRIC.

At the Maritime Exhibition held in Paris in September, 1875, M. Horeau exhibited for the first time a new fabric under the name of *cuir-liège*, or cork-leather, which is described as possessing quite a remarkable combination of new properties, adapting it to numerous applications as a substitute for products now in use. The mode of preparing the *cuir-liège* is as follows: Thin sheets, or pieces of cork, are covered on both sides with an extremely thin India-rubber skin, with any ordinary textile fabric outside of all, the whole becoming one quasi-homogeneous tissue; and although the cork sheets in their normal state are readily permeable by water, friable and brittle, and endowed with very little strength or cohesion, having only the positive qualities of lightness and non-conduction of heat, yet, when subjected to the treatment above described, the resulting product, *cuir-liège*, is extremely supple, endowed with great strength to resist tensile strain, and, while still retaining its comparative lightness and impenetrability to heat, it is rendered water-proof and impermeable to moisture. This new material may be crumpled up, rubbed and wrung like calico and linen in the wash, doubled up any number of times and hammered with a mallet, without injury; the interior web of cork, which is the basis of the fabric, neither cracks nor tears in any way, but preserves its unity. With regard to its water-proof qualities, the articles on exhibition offered conclusive evidences. Boots, shoes, and other articles formed out of *cuir-liège* were shown swimming about upon water, without the water penetrating or in the least deteriorating them. To show the strength of the material, there is exhibited a weight of about half a ton suspended in the air by a strap, two inches wide and about an eighth of an inch thick, made of *cuir-liège*. The external appearance of the material varies according to the nature of the textile material used in combination with the cork; resembling leather, mackintosh, water-proof cloth, but endowed with far superior qualities. The product has, accordingly, already attracted the attention of government officials.

Among the uses for which the new material is claimed to be excellently adapted, combining a notable economy both in weight and cost, may be specified knapsacks, cartridge-boxes, cap-cases, pouches, straps, belts, and other articles of accoutrement, both naval and military; besides tents, awnings, etc., for ambulances and other purposes, in hot climates. Broadly speaking, it is affirmed that *cuir-liège* is a perfect substitute for leather in every case where leather is now used, and that it may be advantageously used in many cases where leather is not adapted.—*Iron*, VI., 426.

UTILIZATION OF LEATHER-WASTE.

Various methods have been proposed for the preparation of an artificial leather from leather parings and trimmings; but the products have had the disadvantage of being without elasticity and of coming to pieces in water. Sörensen, of Copenhagen, has lately patented an improved process for this work, in which the parings are first freed from impurities, and then worked by a special machine into a homogeneous mass. India rubber of any quality is then squeezed, washed, and cut in pieces, and dissolved in oil of turpentine, benzine, sulphide of carbon, or other suitable liquid. The leather is next treated with ammonia-water, forming a gelatinous mass, and well stirred, after which the two masses are united in a mixing-machine. In general, for sole leather, the composition consists of twenty-five parts of solid rubber with sixty-seven parts of the homogeneous mass of leather, and the whole pressed in moulds or rolled, after which it can be manipulated so as to be brought into any desired form.—18 *A*, *August* 11, 1876, 560.

A NEW INDUSTRY.

Among the novelties exhibited at the late fair of the American Institute were certain new products obtained from fir and pine tree leaves, which may ultimately set on foot a new industry. The following account of the invention will be found of interest: Mr. Charles Fulton has devised a process of treating the needles or acicular leaves of the fir and pine with certain chemical solvents, which results in the production of a substance resembling cotton, or perhaps more nearly wool, and having a dark, greenish-brown color. It is prepared of four qualities, adapted respectively for stuffing mattresses, pillows, etc., and for weaving. For the latter purpose, the fibres of the material are separated and treated in machines similar to fulling-mills. Another product of the invention is an excellent thread, which can be woven alone, or mixed with wool, cotton, silk, or other fibres. At the exhibition were samples of cloth, of a very fine texture, made from this thread. It is described as being soft and pliable, resembling a fair quality of flannel. Commenting upon this invention, our informant remarks that there is an enormous amount of raw material for this manufacture in the country, at present useless, which can be obtained simply at the cost of transportation, and which can thus be made available both for textile and paper industries.—6 *D*, XXXIII., 256.

NEW SUBSTITUTE FOR BARK IN TANNING.

The Western tannin plant (*Polygonum amphibium*), which grows luxuriantly in the Missouri River Valley, seems destined to replace oak-bark in tanning. It contains eighteen per cent. of tannin, while the best bark contains but twelve per cent., and large establishments employing it in Chicago find that one third more leather can be obtained with it than with a like quantity of bark. The process of tanning with it is identical with that with bark, but the leather is tougher, finer, and more durable, and accepts a finer finish. The plant is an annual, and can be mowed, dried, and stacked like hay.—5 *C*, XL., 112.

RUSSIA LEATHER.

The best Russia leather (Juchten) exhibited at Vienna was that of Savin, of St. Petersburg, of which the following grades are employed in the manufacture of fancy articles: The Malia-Juchten, sold by the hundred-weight, rhomboidal in grain, and used for articles of more ordinary quality. Pared-Juchten, also sold by weight, generally rectangular in grain, is rather high in price, because it is reduced in weight by paring off the thick parts. It is used for fine articles, either smoothed or in its natural condition. Another grade, smoothed in Russia, and also sold by weight, is rendered still smoother and more highly polished by the Vienna manufacturers by moistening and rolling it, and forms the finest and most expensive article, much in demand of late for the so-called soft articles. Like the other grades, it is found of different sizes and weights. The Werhock-Juchten, named from the Russian superficial measure according to which it is sold, is a coarser grade, has beautiful clear pointed grain, is seldom smoothed, but is generally used in its natural condition for the larger articles.—34 *C*, L., 3.

OLIVE-OIL AND GLYCERINE AS A PARTIAL SUBSTITUTE FOR YOLK OF EGG IN TANNING.

It is proposed by Kathweiner, as a measure of economy, to substitute glycerine and olive-oil, in part, for the yolks of eggs in tanning. Thus in tanning, say, 100 skins, instead of 50 yolks, but 25 might be used, in connection with 4½ fluid ounces of good olive-oil, and 3.4 fluid ounces of the strongest glycerine. The yolks should first be rubbed with a wooden pestle, and the oil and glycerine, previously mixed and well shaken, should be added in a thin stream with continued stirring. If the addition is not too rapid, an excellent emulsion will be formed by continued vigorous stirring for about four minutes. This should then be carefully mixed with the rest of the dressing, and be well absorbed by the hide. The article resembles in the whole process, and in its final finish, that prepared entirely with eggs.—5 *C*, XXXVII., 295.

CEMENT FOR OVENS.

A cement for covering the joints of ovens that has been found excellent in practice and does not crack, but becomes very hard, may be made by mixing equal quantities of finely sifted wood-ashes and crushed and sifted clay, and adding some salt and sufficient water to form it into a dough, with which the cracks are coated when the oven is cold. If this cement is employed instead of clay in setting new ovens they will be almost indestructible.—26 *C*, XI., 15.

RAPID TANNING PROCESS.

Le Havre of the 23d ult. gives the following account of some interesting experiments which took place at Havre on that date in connection with the new and rapid tanning process: "A numerous concourse of merchants, brokers, manufacturers, etc., assembled at the Salle Saint-Cécilé to-day to witness some experiments in unhairing and tanning by the Montoison process. Dr. Limon, of Manchester, superintended the proceedings. A variety of skins were experimented on, from the fresh skin of a calf just killed to the old skins of sheep and goats burned and hardened by the sun of the tropics. There was, of course, some difference in the treatment of each kind, more time being required to unhair the dry, hard skin than that fresh from the abattoir. A short time was occupied in preparing the skins for the unhairing chemical by soaking them in hot water. Subsequently they received two coats of a pasty liquid on the inside, and were piled up, inside to inside, to undergo the action of the composition. Many questions were put in relation to the process, the reply to one of these being that the skin could bear the action of the composition for two entire days without being at all injured. After the skins had been soaked for a short time, the wool came from them absolutely intact, and quite equal to that shorn from the living animal. The manner in which the wool came away from the skin by a touch of the hand created considerable astonishment. In a few seconds the skins were dipped in two special baths to neutralize the unhairing composition. The afternoon was devoted to tanning experiments, which proved the invention to be a complete success. Many competent gentlemen did not hesitate in declaring their opinion that the rapidity of the process was little short of marvelous, and that the leather produced under it was to all appearance fully equal to that produced by the tedious methods now employed."—*Engineer*, XL., No. 1033, 263.

A NEW CEMENT.

The following recipe is asserted to produce a cement of very superior character for uniting stone and resisting the action of water. It becomes as hard as stone, is unchangeable in the air, and resists the action of acids. It is made by mixing together nineteen pounds of sulphur and forty-two pounds of pulverized stone-ware and glass. This mixture is exposed to gentle heat until the sulphur melts, when the mass is stirred until it has become thoroughly homogeneous, and is then run into moulds and permitted to cool. When required for use it is heated to 248° Fahr., at which temperature it melts, and may be employed in the usual manner. At 230° Fahr. it becomes as hard as stone, and preserves its solidity in boiling water.

ATTACHING LEATHER TO METAL.

A method of affixing leather to metal, so that it will split before it can be torn off, consists in digesting a quantity of nut-galls, reduced to powder, in eight parts of distilled water for six hours, and filtering it through a cloth; then dissolving one part by weight of glue in the same quantity of water, and allowing it to remain twenty-four hours. The leather is to be overlaid with the decoction of nut-gall, and the solution of glue applied to the metal, previously roughened and heated. The leather is then laid upon it, and dried under pressure.—4 *B*, V., 186.

MARINE GLUE.

An excellent marine glue, which can be melted at the same heat as common glue, can be applied with a brush, sets very quickly, is elastic and perfectly soluble in water, can be made by dissolving two ounces of India rubber in half a gallon of mineral naphtha. When the rubber is dissolved, add twice the quantity of shellac to the naphtha, place the whole in an iron vessel, apply heat cautiously, stir till well mixed, and then pour out on a slab to cool.—18 *A*, XXII., 97.

DURABLE GLUE.

A very permanent and durable glue, which may be called chrome glue, is made by adding to a moderately concentrated solution of the glue one part of acid chromate of lime in solution to five parts of gelatin, this salt of chrome being thought better adapted to the purpose than bichromate of potash, which is usually used. The glue thus prepared, after being exposed to the light, becomes insoluble in water, in consequence of the partial reduction of the chromic acid. This preparation can be used in cementing glass objects liable to be exposed to boiling water, the treatment being the ordinary one of applying the glue to both surfaces of the fractured object, and then binding them together until dry, and exposing them for a sufficient length of time to the light, after which boiling water will have no action upon them. It is suggested that this preparation will be better adapted to cementing the covers on glass slides than any now in use. The same preparation can be applied for making fabrics water-proof, especially sails of ships, awnings, etc., where no great flexibility is necessary. Two or three applications of the glue, either by immersion of the object in it or by the use of a brush, will answer the purpose. Roofing-paper is also rendered impervious, even when exposed to long-continued rains.—13 *B*, *February* 6, 1876, 158.

WATER-PROOF AWNINGS.

Awnings can be rendered water-proof by plunging the fabrics into a solution containing twenty per cent. of soap, and afterward into another solution containing the same percentage of sulphate of copper. Wash, and the operation is finished.—*Engineer*, No. 1034, 281.

LIQUID GLUE.

Dilute officinal phosphoric acid with two parts by weight of water, and saturate with carbonate of ammonia; dilute the resulting liquid, which must still be somewhat acid, with another part of distilled water, warm it on a water-bath, and dissolve in it sufficient Cologne or Flanders glue to form a thick, sirupy liquid. Neither glycerine nor sirup should be added, and it should be kept in well-closed bottles.—18 *C*, *February*, 1876, 95.

GELATIN AND BICHROMATE OF POTASH CEMENT FOR GLASS.

Dr. Schwarz has employed with success, for cementing broken glass-ware, a five to ten per cent. solution of gelatin, to which one part of bichromate of potash for each five parts of gelatin had been added, in solution. Both surfaces of fracture were coated, as uniformly as possible, with the freshly made solution, and held in position with a cord, and exposed to sunlight for several hours, after which the cement was not affected by hot water, and the fracture could scarcely be detected.—14 *C*, CCXVIII., 61.

COPPER ALLOY THAT WILL ADHERE TO GLASS.

The following alloy, it is said, will attach itself firmly to glass, porcelain, or metal: Twenty to thirty parts of finely pulverulent copper (prepared by precipitation or reduction with the battery) are made into a paste with oil of vitriol. To this seventy parts of mercury are added, and well triturated. The acid is then washed out with boiling water, and the compound allowed to cool. In ten or twelve hours it becomes sufficiently hard to receive a brilliant polish, and to scratch the surface of tin or gold. When heated it is plastic, but does not contract on cooling.—*Iron*, V., 683.

A NEW GLASS.

Following closely upon the public announcement of the results obtained by MM. De la Bastie and Peiper in the art of toughening glass comes the statement that Mr. Mackintosh, of Westminster, England, a civil engineer, who is represented to have devoted much time to the processes of tempering metals and alloys, has invented a method of hardening glass. From what has been published, it appears that Mr. Mackintosh, in his process, has started from his theory that the lower the temperature of the liquid bath in which certain heated bodies are plunged, the harder such bodies become. Mr. Mackintosh affirms, as the result of his observations, that glass, graphite, uncrystallized carbon, slag, and analogous substances are rendered extremely hard when treated in the manner usually indicated for metals. The following is a brief description of the method adopted by the patentee: A quantity of the fused or nearly fused glass is first placed in iron or other moulds to shape the material; from these it is removed to moulds of platinum, in which it is reheated to partial or total fusion, and thereupon suddenly deprived of its heat by immersion in a mixture of iced water and salt, or other freezing mixture that produces extreme cold. The substance of the process consists, therefore, in heating the glass to a high temperature, and then rapidly cooling it in a very frigid fluid.—*American Builder*, XI., 188.

HARDENING GLASS, VULCAN GLASS, AND METALLIC GLASS.

The demand of Bastie for the secret of his process from the German Glass Manufacturers' Association was considered so exorbitant that it refused to treat with him further in regard to it, and purchased from Peiper, of Dresden, for $60,000, the process for the manufacture of the similar so-called Vulcan glass discovered by him. He was not ready, however, to communicate his process for several weeks, and, in the mean time, Lubische & Riederer, near Klitschdorff, succeeded in making a so-called metallic glass, which is said to be identical in character with that made by his process.—13 *C*, *May*, 1875, 573.

HARDENING GLASS.

It is said that a company has been formed at Bourg, in France, for manufacturing one of the new kinds of hardened glass, evidently that made by M. De la Bastie. The German glass-makers, not being able to purchase the invention of the French company, and having learned that hardness is given to glass by dipping the same, while it is heated to a half-liquid state, into a hermetically closed bath of oil or fat (substances which melt far below the boiling-point of water), have undertaken its manufacture. In Silesia, where repeated experiments have tested the qualities of De la Bastie's glass, another new glass has been invented by Lubische & Riederer, which is called metal glass, and is so hard that when a pane lies on the ground, and a leaden ball of an ounce weight falls upon it from an elevation of twelve feet, it receives not the slightest impression.—12 *A*, XI., 474.

ARTIFICIAL GEMS OF HARDENED GLASS.

Mackintosh has patented a process for hardening glass, mainly for the manufacture of very hard artificial gems, by which he hopes to produce these superior to the diamond in hardness, and to furnish a glass powder superior to diamond dust and emery for grinding purposes. The process differs from that recently introduced for hardening glass, as the glass is cooled in platinum moulds, in a freezing mixture.—8 *C*, XII., 1875, 311.

WATER-GLASS FOR WASHING COTTON USED IN CLEANING MACHINERY.

According to the Hessische *Gewerbe-Blatt*, cotton that has been used for cleaning machinery may not only be completely cleansed by treatment with water-glass without affecting the fibre or color, but it is also rendered softer and more porous, and consequently preferable to new material, since it takes up oily matter more readily.—6 *C*, 1875, 29.

TINNING IRON TACKS.

According to Wiley, the process is to triturate chloride of zinc with a large quantity of oil, and heat it in an oscillating vessel, and, as soon as it has reached the proper temperature, throw in the tacks and the necessary quantity of metallic tin, and after a few seconds dip them out with wire gauze, and cast them into water.—5 *C*, XL., 104.

BRILLIANT ZINC COATING ON BRASS AND COPPER.

The following simple process is recommended by Böttger: Boil a large excess of so-called zinc dust some time with a concentrated solution of caustic soda, or potash, and place the copper or brass articles to be coated in the boiling liquid. By continuing the heating, after a few minutes a beautiful, mirror-like film of zinc will form upon them, by the decomposition of the alkaline solution, in consequence of their electro-negative character in combination with the zinc. It is suggested that the process is applicable to the preparation of disks for dry-piles, and also for forming a layer of tombac, by heating a copper article thus coated carefully to about 248° to 284° (best under olive-oil), when the zinc will unite with the copper support to form a gold-tinted tombac, and the article need only be quickly cooled in water, or some other suitable liquid, as soon as the desired color is apparent. —18 *C*, VII., 345.

ENAMELING ON BRASS AND GERMAN SILVER.

The adhesion of enamel to brass and German silver, it is said, may be most perfectly effected by first engraving or pressing the design to be enameled into the alloy, and then coating the whole object, or only the depressed design, galvanically with copper. The enamel can be fused upon this surface as usual, and may then be bronzed or silvered, or treated in any usual way.—5 *C*, XL., 399.

BRONZING IRON CASTINGS.

A process for bronzing iron castings, patented in different countries by Gaudoin, Mignon, and Bouart, differs from preceding ones in dispensing with the intervention of a third substance, and at the same time rendering the film of copper so adherent that it will not scale off; but in some cases the iron and copper have been found to scale off together. The film is also said to be perfectly uniform in thickness upon the elevations and depressions, and on the undercut portions, and capable, in the hands of a skillful workman, of acquiring a close resemblance to bronze. The process has been employed at the large foundery of ornamental iron-work at Val d'Osne on castings of all sizes up to colossal statues, some of which have withstood the weather for a summer and two winters without the least injury. The cost is not more than double that by the usual process. A similar method may also be employed for tinning copper and cast-iron vessels.—5 *C*, XL., 383.

NICKEL-PLATING PROCESS.

Plazenet employs a bath composed of 87.5 grammes of sulphate of nickel, 20 grammes of sulphate of ammonia, 17.5 grammes of citric acid dissolved in 2 liters of water. Another recipe much used in France is formed of a solution of 4 parts of nitrate of nickel in 4 of liquid ammonia and 150 of water, in which 50 parts of sulphate of soda have been dissolved. With a moderate current the operation is completed in a few minutes. When the film of nickel is of sufficient thickness the objects are withdrawn from the bath and dried with sawdust.—3 *A*, VI., 523.

PRODUCTION OF A BROWNISH PATINA ON ZINC.

A solution of molybdic acid, or of molybdate of ammonia, in very dilute aqua regia, or of molybdic acid in excess of very dilute solution of caustic soda, according to Professor Kletzinsky, produces a very pleasing, adherent, brownish patina, inclining to iridescence, upon articles of cast zinc immersed in it.—18 *C*, 1875, 1555.

COATING MIRRORS WITH AN ALLOY OF GOLD AND PLATINUM.

Five hundred grains of spongy platinum are dissolved in 50 cubic centimeters of hydrochloric and 50 of nitric acid, and the mass is evaporated to dryness. It is then powdered and digested with 2000 grains of essence of lavender, 100 grains of turpentine, and 25 grains of sulphuretted turpentine resin (*baume de Soufre terebenthine*). Thirty grains of gold, made into chloride, are dissolved in 500 cubic centimeters of water and an equal amount of ether. The liquid is shaken, and the ethereal solution added to the platinum and allowed to evaporate spontaneously. Fifty grains of litharge, fifty grains of lead borate, and 100 grains of lavender-oil are then added, and the mixture is shaken, after which the mirror is coated with it, and kept at a red heat until the composition is burned in.—21 *A*, XI., 928.

NICKEL-PLATING SOLUTION.

Hesz prepares a nickel-plating solution that yields beautiful results, by mixing the liquid obtained by evaporating a solution of one-half ounce of nickel in aqua regia to a pasty mass, and dissolving it in one pound of aqua ammonia, with that obtained by treating the same quantity of nickel with a solution of two ounces of cyanide of potassium in a pound of water. More cyanide of potassium renders the deposit whiter, and more ammonia renders it grayer.—18 *C*, VI., 185.

REFLECTOR FOR MOULDERS.

A novelty of this kind has lately been invented, the object of which is to do away with the inconvenience often suffered by moulders in being compelled to pour off metal in the imperfect light of winter, or during obscure days, and which often causes serious losses and delays.

The device in question involves no extra cost for illumination, and consists simply of a concave disk of metal, nickel-plated to secure good reflecting qualities, which is placed upon the ladle handle, and throws a strong light from the molten metal directly over the edge of the ladle into the sprue-hole. The moulder is thus enabled to pour the metal into the flask with great certainty.—*Iron Age, October* 21, 7.

SELF-FEEDING NAIL-MACHINE.

A machine of this description, the invention of F. A. Gleason, of Brooklyn, is in operation at the nail factory of the Albany Iron Works. The machine is making sixpenny nails at the rate of 200 to 300 per minute, and but one attendant is needed for five or six of the machines. The feeding device, which is its chief novelty, consists of, first, a plate-box, holding a thirty-pound plate. The lower plate is discharged immediately after the first plate has been cut up; second, an automatic nipper, which seizes the plate, carrying it down to the cutters and feeding it until consumed, then returning and discharging the scrap in a receptacle provided for that purpose. The feeding process is quite simple, and the only parts liable to friction and constant wear are an eccentric, elbow, and their connections. The machine runs rapidly, and becomes very hot; but this defect, it is believed, can easily be remedied.—*Bullet. Am. Iron and Steel Assoc.*, IX., 281.

FLEXIBLE MANDRIL FOR BENDING METAL PIPES.

At a recent meeting of the Franklin Institute the following ingenious device for the above purpose was exhibited. The mandril consists of a coiled or spiral spring, made of square steel wire, and of such size as to be freely inserted into the pipe to be bent. The pressure may then be applied in any convenient manner, but preferably it should be done with a block of wood shaped to the curve to which it is desired to bend the pipe, its edge being grooved to fit the outside of the pipe. After the bend is made the mandril can readily be withdrawn by turning it from one end in the direction in which it is wound, which action slightly reduces its diameter, and by this means it is *screwed out* very easily. The old method of bending pipes of copper or brass is to fill them first with rosin, lead, or sand, and requires considerable skill, being both tedious and uncertain, especially for large pipes; and the crimping of the inner sides and stretching of the outer sides are very unequal, the pipe always requiring to be hammered and filed into shape at the conclusion of the bending. The new method, besides requiring much less skill and scarcely one twentieth of the time of the old, obviates all the above-named objections, leaving the pipe so near perfectly round that the eye does not detect the variation, and its surface so smooth as not to necessitate filing.—1 *D*, LXX., 22.

TEMPERED STEEL BRUSHES.

A recent novelty in the metal trade has been introduced by a French manufacturer, in the shape of brushes made of tempered steel wire. These implements, according as they are intended for various uses—cleaning tubes, or the sheathing of ships, iron bridges, sluice-gates, and iron construction generally—are of different forms. They are also made, like the old metallic brushes, for polishing or scratching metals, for stone and marble, for smoothing flooring and the decks of ships, and for many other purposes. The same maker has produced a new scraper for the special purpose of cleaning locomotive boilers. This special device is a spiral brush, in which, however, the steel wire is replaced by pieces of steel spring, and is said to be not only very effective, but also very durable.—*Iron Age*, *September* 2, 1875, 1.

RAPIDITY OF FILTRATION.

Dr. Fleitmann has called attention to the fact not generally known that, contrary to what at first sight might be expected, filtration is much more rapid through thick paper than through thin, and that it is almost twice as rapid through a double filter as through a single one, and still more rapid through a triple one. He says that he has taken advantage of this fact for a number of years by employing in quantitative analyses a filter of heavy paper beneath the thin one of Swedish paper.—15 *C*, XXX., 170.

NEW APPLICATION OF INFUSORIAL EARTH.

Böttger publishes the observation that when an alcoholic solution of any of the coal-tar colors is mixed with a sufficient quantity of infusorial earth, water added, and the mixture filtered, the liquid will run off clear, while the earth retains all the pigment. Hitherto the compounds of alumina have been used for the production of the so-called lakes, and it is quite probable that the above-noted behavior of this material, which is very cheap, may find important applications in the arts.

CONDENSING BEER FOR PRESERVATION.

A patent for condensed beer has been taken out by Mr. Lockwood. The liquid may be taken at any stage of fermentation, although it is thought best to treat it when fit for drinking. It is evaporated in a vacuum until a large part of the water and alcohol is distilled away, and the beer is reduced to a thick, viscid fluid of about the consistency of molasses. The alcohol and water pass off in vapor, which is condensed, and the alcohol subsequently obtained by redistillation is mixed with the condensed beer, either before bottling or at any time afterward. In this way beer may be reduced to one eighth or one twelfth its original bulk, and it is said to keep for any length of time. To restore the beer to its first consistency, it is only necessary to add the bulk of water distilled off, with a small quantity of yeast or other ferment, and in forty-eight hours the beer will be ready for bottling. If charged with carbonic acid in a siphon-bottle or receiver, the necessity of renewing the fermentation is obviated.—18 *A*, XXII., 397.

NEW FORM OF PAPER FILTER.

Professor Stolba states that he has employed the following form of paper filter for a long time in analytical determinations, as well as for other purposes. He recommends it, principally, on account of the comparatively small amount of ash, where small quantities are to be determined, since but little more than half as much paper is employed. Although less water is used for washing, the filtration is somewhat slower, since it does not fit the walls of the funnel so closely. The paper is simply folded once in the middle, and the one end then closed by a sharp narrow fold, formed by lapping the paper several times, each time rubbing the fold with a paper-knife or agate pestle. It is then rounded, like an ordinary filter, placed in the funnel dry, and moistened, and the fold pressed against the funnel with a glass rod. He suggests that other materials besides paper might be used, and that collodion, or some other cement, might be used instead of the repeated folding.—14 *C*, CCXVI., 445.

ANOTHER DIRECT SODA PROCESS.

Herr Viedt has ventured the opinion that common salt may be converted into caustic soda by the simple action of steam at high temperatures. The chemical changes involved in the process would be simply the production of caustic soda and hydrochloric acid, which last, being gaseous, could readily be removed. The experiments he has undertaken upon this subject have, however, only met with partial success, possibly because of imperfect apparatus. Should his expectations be realized in future experiments, a material advance in the alkali manufacture would result.

PREPARATION OF BLOOD AS A POWDER.

Mr. Le Bon says if blood be evaporated under diminished pressure at the temperature of the body, in a certain apparatus, it will be obtained as a powder soluble in water or in an acid solution of pepsin, and showing the characteristic absorption-bands of hæmoglobin, which constitutes eighty-six per cent. of the corpuscles. This method is suggested by the author for the utilization of the blood for food or for other purposes.—21 *A*, *February*, 280.

AIR-TIGHT JOINTS.

Professor Crookes states that in some observations made by him it has been necessary to preserve his apparatus within a vacuum for a number of hours, and, if possible, days. To this end it was very important to secure a cement that would unite the joints of his apparatus in such a way as not to allow the leakage of air under an ordinary pressure of ten to fifteen pounds to the square inch. Whenever possible, glass tubes should be united at the joints by fusion, and when this is impossible mercury joints should be used, and it is found that the best way to construct these is to have a well-made perforated conical stopper of very pure India rubber let into the wide funnel tube of the joint and carrying the narrow tube. Before fitting the tubes into the India rubber, this is heated in a spirit-lamp until its surface is decomposed. It is then fitted into its place, mercury poured over, and oil of vitriol on the top of that, and when well made this joint seems entirely secure. Ordinary India-rubber joints are of no use in these experiments, as when the vacuum is nearly perfect they allow oxygenized air to pass through as readily as the pump will remove it. A cement that lasts satisfactorily for a few hours, but not over a day or two, is made by a mixture of eight parts of resin and three of beeswax. —7 *A*, XLVIII., 86.

TO PREVENT SHAFTING ACCIDENTS.

Many suggestions have from time to time appeared upon the subject of preventing or lessening the liability to accidents arising from the entanglement of some portion of an operative's garments in a swiftly revolving shaft, which accidents are of too frequent occurrence in our large manufactories, and are of a distressing or fatal character. One of the simplest methods of rendering these casualties impossible, without introducing the necessity of constructing a railing or fender about the moving piece in dangerous places, is to cover the shaft with a loose sleeve along its entire length. This may be made of sheet-tin or zinc, and to be removable if desired. It should be covered within and at the ends with leather, to prevent noise. Arranged in this manner, the friction between it and the revolving shaft would be sufficient to cause the sleeve to rotate with the latter; but in the event of any decided resistance being brought to bear upon it, as in the case of the engagement of a workman's garment, the sleeve would at once be brought to rest, and permit of its extrication without accident. The same idea of loose covers may be applied to cog-wheels or pulleys, and prove an invaluable protection against loss of life or injury to the person.—6 *D*, XXXIII., 69.

THE INDUSTRIAL EMPLOYMENT OF THE LIGHT PRODUCTS OF PETROLEUM.

We have taken the opportunity in these pages, when upon the subject of petroleum and its products, to dwell upon the desirability of the discovery and general introduction of industrial processes by which the lighter products of the refinery—gasoline and the naphthas—would be withdrawn from their present frequently dangerous, reprehensible, and illegal uses, and their admirable lighting and heating qualities utilized in a manner consistent with common-sense and the safety of life and property. One of the most natural and promising directions in which to look for this consummation is to be found in the efforts of inventors to convert these valuable but troublesome products into permanent illuminating gases, in which condition their consumption is attended with no danger.

CARRÉ'S CARAFE ICE-MACHINE.

M. Carré, whose name is well known in connection with the invention of several forms of ice-machines, has lately added to his achievements in this field by designing another contrivance for the same purpose, which, for effectiveness, simplicity, and general utility, if accounts may be credited, bids fair to surpass every thing of this kind that has yet been produced. The new machine can be easily operated by even an inexperienced person after one or two trials, and may be properly designated as a "family ice-machine."

The essential parts of the apparatus consist of an air-pump, capable of producing a good vacuum, a horizontal cylindrical receiver, partially filled with sulphuric acid, and the carafe or flask, in which the water is frozen, and which is connected with the receiver (and consequently with the pump) by a suitable pipe or tube provided with a necessary stop-cock. The carafe is suspended from the tube by means of an India-rubber ring, which insures an air-tight joint between it and the receiver. The operation of the apparatus is as follows: The carafe, an ordinary flask with elongated neck and swelled body, is half filled with water, and suspended from the table before mentioned by means of the rubber ring or cork. In order to insure the perfect tightness of the joint between the flask and the tube, upon which the success of the operation of freezing is largely dependent, the stop-cock upon the tube is closed, a small quantity of water is poured between the cork and rim of the glass (to render any subsequent leakage visible), a few strokes of the pump are made to exhaust partially the acid receiver, and the stop-cock is turned on. The effect of this preliminary manipulation is to firmly attach the flask to the tube by atmospheric pressure, and insure a perfectly air-tight joint. The pump is now worked rapidly for a few minutes, when the water in the flask begins to evaporate rapidly, and at last bursts into violent ebullition. The vapor evolved is drawn through the receiver containing the acid, which at once absorbs and condenses it. Very soon a few filaments of ice will be observed to form in the water, and the pumping is to be continued for a few minutes longer, after which a stop-cock connecting the pump with the receiver is closed and the flask left on the tube. In fifteen or twenty minutes afterward the water will be found to be frozen throughout. The flask can then be removed and another substituted, and if the stop-cock between the flask and the receiver was closed previous to the removal of flask No. 1, the vacuum in the receiver will have been preserved, and much of the preliminary pumping may be dispensed with in the case of flask No. 2.

The theory of this operation is the same as that of the familiar lecture-room experiment of freezing water by its own evaporation. In the case of M. Carré's device, the rapid evaporation of the water effected with the pump by relief of pressure is materially aided by powerful absorptive qualities of the sulphuric acid in the receiver; and in order to insure better contact of the acid and vapor, an ingenious apparatus called the agitator is provided by the inventor, which stirs up the acid during the motion of the pump. This agitator consists of a rocker furnished with paddles, and extending the length of the receiver, the motion of the rocker being obtained by means of a lever attached to the pump-handle. The apparatus is carefully constructed, so as to avoid the entrance of acid either into the flask or the pump, so that the employment of the acid need afford no inconvenience to the introduction of the machine in private houses. The acid may be removed and replenished when necessary by means of a suitable opening provided on one end of the receiver. When the acid is fresh, the freezing operation is much more rapid than when a number of carafes have been frozen, a natural consequence of the weakening of the acid by dilution from the absorbed vapor. When the efficiency of the acid has become notably impaired, it must be removed and replaced by fresh material. The cost of freezing a single carafe is estimated to average about one half to two thirds of a cent where the acid is thrown away after its work is performed; where the diluted acid can be utilized, this estimate will of course be materially lessened. The carafe, or decanter, half filled with ice, is to be completely filled with water, and is thus brought upon the table, being replenished with fresh water when empty. The shape of the decanter renders the melting a slow process, and when once partially filled with ice it will supply cold water for the greater part of the day. If desired, however, it is obvious that the same machine, with a suitable modification of the water-vessels, can be made to furnish ice blocks of any size or form.—*American Exchange and Review*, XXVII., 272.

N. MATERIA MEDICA, THERAPEUTICS, AND HYGIENE.

JOLLY ON PHOSPHATE OF LIME.

Dr. Jolly, in correction of a previous memoir on the phosphate of lime, remarks that of the two elements, phosphoric acid and lime, constituting the soluble and insoluble, the former is absorbed in a certain proportion at once; the second, or the lime, is rejected almost entirely by the intestinal canal.

The soluble preparations of the phosphate of lime act finally as acid principles; then, in consequence of the changes which they undergo in the intestines, they act secondarily as phosphatic agents of another base.—12 *B*, *June* 30, 548.

HYPODERMIC INJECTION OF LACTATE OF SODA.

Dr. Preyer, of Jena, has called renewed attention to the fact that a preparation of lactate of soda injected under the skin, or introduced into the stomach, will produce a somnolence quite similar to natural slumber. The application of this through the mouth has been tried with much success in some cases, although in others it has been quite inefficacious.—13 *B*, *April* 22, 1876, 534.

THERAPEUTICAL VALUE OF SILPHIUM.

Considerable attention has lately been paid to the subject of the therapeutical value of plants of the genus *Silphium*, to which the well-known "compass weed" of the Western prairies belongs. It is used more particularly in cases of phthisis, and, according to Dr. Laval, produces the following results: First, the reappearance of appetite, if this has disappeared; second, the relief of the difficulty in breathing and an easier respiration; third, a much less painful cough, the phlegm being more natural, and indicating less the phenomena of tuberculosis. All these effects, increase of appetite, augmentation and modification of the bronchial secretions, and easier respiration, show that important functional activity is produced by the use of the medicine.

According to other authors, however, caution is to be exercised in its administration, as in certain stages it may do more harm than good. Further and more extended experiments will be required in order to determine precisely how to apply this remedy, and, indeed, whether it has the virtues attributed to it by its sanguine advocates. It is to be remarked that the ancients attached great therapeutic virtue to the use of silphium, considering it as a true panacea.—11 *B*, *July* 1, 353.

NEW SUBSTANCES OF THE MATERIA MEDICA.

At the recent Pharmaceutical Congress held at Bristol, England, an account was given by Mr. Groves, the president, of sundry new drugs, some of which are probably destined to occupy a prominent place in the Materia Medica. Most of them were brought from South America, and as yet are but imperfectly understood. One of these is known as *Butea*, which is said to contain a basic substance, which combined with sulphuric acid is white, almost like cinchona, and is exported to Europe in great quantities to adulterate quinine. *Erva de Rato*, a cinchonaceous plant, used in Brazil for killing rats and mice, is another drug which is said to exert an action upon the heart similar to that of digitalis. Certain substances, known as *Goa*, *Bahia*, and *Araroba powders*, and claimed to have quite different effects, have lately been shown to be one and the same thing, the plant having been exported from Bahia to Goa, and thence introduced into Europe. The essential principle of these powders, as recently separated, has been called *Chrysardhin*, and contains from eighty to eighty-four per cent. of pure chrysophanic acid, long known as a constituent of rhubarb roots. This is considered in Brazil as almost a specific for certain forms of skin disease. Another substance mentioned was *Gurgun balsam*, an oleo-resinous fluid, obtained by making incisions in the bark of *Dipterocarpus lævis*. This, for a time, was used principally as an adulterant of copaiba, but is now believed to be a very valuable agent in the treatment of skin diseases, especially leprosy; indeed, it is said that *Gurgun balsam* renders this disease quite tractable, sometimes curing it, and in most cases alleviating it. It is applied in emulsions with limewater, internally and also as an ointment. It is also urged as applicable in cancer. An elaborate series of experiments is now being prosecuted by the Indian government to determine its availability in similar cases. Salicylic acid was also dwelt upon as an important addition to the resources of the pharmaceutist. Its great superiority to carbolic acid in most cases was pointed out, which, combined with its much less objectionable taste and flavor, will doubtless call it extensively into use. Introduced in small quantities into the water in which leeches are kept, it preserves those animals in a healthy condition, showing its non-poisonous character. The speaker thought its future applications were more likely to be internal than external. Reference was made to the artificial preparation of oil of winter-green (salicylate of methyl), prepared from the artificial acid, and possessing the taste and odor of the oil of the plant on distillation. The interesting fact was stated that salicylic acid can be obtained in nearly pure crystals from the essential oil of *Andromeda Leschenaultii*, a plant growing in inexhaustible profusion on the Neilgherry Hills. By saponifying the oil with potash and adding a mineral acid, the salicylic acid is precipitated in a state of purity. If this is distilled with lime and sand, pure carbolic acid is obtained. It is thought that both these acids can be obtained from the plant at a cost of a few shillings a pound. A substance has lately been derived from the roots of the *Digitalis purpurea*, which is so poisonous as to render doubtful its availability for medicinal purposes.—18 *A*, *October* 18, 1875, 89.

ON JABORANDI.

Among the most remarkable objects of the Materia Medica lately introduced to notice is one known as *Jaborandi*, and especially noteworthy from its power of producing a rapid, prompt, and intense salivation. The plant is a native of the Empire of Brazil, and known to botanists as the *Pilocarpus pinnatus*. Four grammes of the leaves dissolved in 125 grammes of boiling water, or in 20 grammes of alcohol, will bring about at the end of twenty to forty minutes a perspiration which continues from one to two hours, and is enough to completely saturate the clothing or even the bedding of the patient with moisture, to an amount estimated at from three to five hundred grammes.

Dr. Albert Robin has lately received the sum of 1500 francs, from the Barbier prize, for an essay upon the applications of this substance; and, in addition to the determination of the facts just mentioned, he has shown that in the amount of perspiration thus produced there is an elimination of urea of about one gramme, and of chlorides of about one gramme and a half. Experiments have been tried also upon dogs and guinea-pigs, which, as not being provided with sudorific glands, gave no result, and even with horses, which have such apparatus, no satisfactory experiment could be made. A secretion of saliva, according to Robin, commences and continues equally with that of perspiration, and he determined an elimination of 400 to 500 grammes in about two hours—an amount forty times that of natural salivation. The saliva proved to be viscid, very alkaline, and charged with mineral salts, especially the carbonates and chlorides. The secretions of tears, and of the bronchial and nasal mucus, are somewhat increased, but much less in proportion than the others mentioned. The occasional nausea produced by the application of Jaborandi is due, according to Robin, to the swallowing of the saliva, which should therefore be carefully avoided. The urinal secretion was slightly diminished by the use of this drug. The therapeutic value of Jaborandi, the author considers very great, and among other applications is the treatment of acute articular rheumatism, in which, in nearly every instance, there was a notable diminution of pain during and after its action, a better sleep, and a decided decrease in the duration of the malady after two or three administrations for several days. Three patients who had muscular rheumatism were promptly relieved; two were cured of pneumonia, and the third case was fatal from causes beyond the reach of any medicine; very favorable results were produced in cases of bronchitis and asthma; and in twelve cases of Bright's disease, every one received a decided benefit from the treatment. Another paper on Jaborandi, which likewise received a prize of 1500 francs from the Academy of Sciences, was that by Hardy, upon the active principle of Jaborandi, which he calls *pilocarpine*. This is an alkaloid, solvable in water and in alcohol. It has been isolated, but not yet actually obtained in a crystallized form. So far as can be judged, the alkaloid contains all the active properties of the plant, and can, consequently, be used in many cases to much better advantage.—6 *B*, *December* 22, 1875, 1333.

THERAPEUTIC QUALITIES OF COD-LIVER OIL AND QUININE.

The *Paris Medical Journal* commends a certain preparation of quinine and cod-liver oil as having excellent therapeutical virtues. The experiment had been frequently made of dissolving quinine with cod-liver oil, but without success; subsequently the object was accomplished by combining the alkaloid with oleic acid, and then dissolving this oleic acid in a given quantity of cod-liver oil. The French preparation of this substance is arranged to give five centigrammes of quinine to each tablespoonful of the oil.—1 *B*, *January* 2, 1876, 206.

CHEAP QUININE.

It is reported that the extensive cinchona plantations in British Sikhim have lately begun to furnish an efficient febrifuge, sold at a cheap rate. The resident manager of the plantation at Darjeeling writes to Dr. Hooker that they expect to collect about ninety tons of the dry bark during this season; that they are making it on the spot into a febrifuge which is evidently quite as effectual as quinine. They are making from forty to fifty pounds a week, and expect to increase the quantity, and hope to sell this at about fifty cents an ounce.—12 *A*, *January* 6, 1876, 196.

CHLORAL AND PICROTOXINE.

Dr. Christian Brown has shown that the hydrate of chloral is physiologically the antagonist of picrotoxine, when administered to hares and rabbits and guinea-pigs, and that life may be saved, after a fatal dose of picrotoxine, by administering the chloral within fifteen or twenty minutes of the taking of the other substance. This antagonism is subject to two restrictions: first, when the dose of picrotoxine is large enough to destroy life before the chloral has had time to act; and, second, when the dose is too great to be combated, excepting by a fatal dose of chloral. On the other hand, however, picrotoxine is only to a very limited degree the antagonist of chloral, merely mitigating the hypnotic effects upon the brain and nervous system. The minimum fatal dose of the hydrate of chloral for the hare is twelve grains for each pound of weight of the body. With the cat it has been found that there is practically no antagonism between picrotoxine or strychnine and chloral. Picrotoxine and hydrate of chloral administered together to a cat produced death by stopping the action of the heart, apparently without exciting any destructive or exhausting influence upon the superior nervous centres. The energy of the action of hydrate of chloral, however, in its fatal minimum dose, according to Dr. Brown, is in proportion to the development of the cerebral hemispheres.—12 *B*, LXXXIX., 142.

ACTION OF BROMIDE OF LITHIUM.

The use of bromide of lithium as a remedy appears to be increasing since the first suggestion of its application by Dr. S. W. Mitchell, of Philadelphia, in 1870. Dr. Levy, a French physician, has reported as the result of careful investigation that while the bromide of potassium exercises a decided action on the muscular system, bromide of lithium has apparently none in this respect, but acts more energetically and more rapidly than the potassium upon the spinal marrow and nerves of sensation. He also states that there is an influence of the bromide of lithium, though slight, upon gout; but it is quite difficult to prove any influence in diminishing the quantity of uric acid secreted or contained in the urine. It has, however, a very decided sedative action upon cerebrospinal cases, and has favorably modified various diseases, especially epilepsy. While its action in this respect is more marked than that of the bromide of potassium, it has the additional advantage of not acting upon the heart—a matter of much moment in some cases. He thinks, therefore, that in any event the bromide of lithium deserves an honorable mention in therapeutics. The doses in which Dr. Levy administers this remedy are 50 centigrammes for the gout, and 20 centigrammes for such nervous conditions as hysteria, insomnia, etc. For epilepsy he uses at first 50 centigrammes, increasing the amount gradually to 2½ or 3 grammes. There is no danger, he thinks, in giving doses even greater than this.—12 *B*, LXXXVIII., 286.

EXTRAORDINARY ACTION OF NITRATE OF AMYL.

The nitrate of amyl has within the last few years obtained a remarkable importance, owing to its extraordinary action upon the body. It appears that Professor Guthrie, a distinguished chemist, while distilling nitrate of amyl from amylic alcohol, observed that the vapor when inhaled quickened his circulation, and made him feel as if he had been running; there was flushing of his face, rapid action of his heart, and breathlessness. On making a careful and prolonged study of the properties of this singular body, Dr. Richardson discovers that it produces its effects by causing an extreme relaxation, first of the bloodvessels, and afterward of the muscular fibres of the body. To such an extent does this agent thus relax, that, finding it would overcome the tetanic spasm produced by strychnia, he has ventured to propose its use in some of the most extreme spasmodic diseases, and thus far with surprising success. Under the influence of this agent one of the most agonizing of known human maladies—angina pectoris—has been brought under such control that the paroxysms have been regularly prevented, and, in one instance at least, altogether removed. Even tetanus, or locked-jaw, has been subdued by it, and, in two instances of an extreme kind, so effectively as to warrant the credit of what may be truly called a cure.

INFLUENCE OF ALTITUDE UPON THE HEALTH.

Dr. Gleitsmann, physician in charge of the Mountain Sanitarium for pulmonary diseases at Asheville, North Carolina, states that in the treatment of pulmonary diseases several historical epochs may be recognized—that in which the sea climate was considered as most beneficial, that in which dry climates were advised, and that in which elevated regions were recommended. The most recent theoretical investigators, as well as many physicians, however, agree that in the removal of the patient to elevated regions we do for him the very best that can be done. Dr. Gleitsmann finds that the success attained by the removal of the patient to southern climates, without securing a greater altitude, amounts simply to a relief of the symptoms, only warding off fresh injury; the patient, after returning home, has not acquired that power of resistance which alone can prevent a new catarrh or inflammation from attacking the lungs. The general effect, on the other hand, of a mountain climate must be considered as an active one, since increased demands are made upon the functions of the organism from all sides—mechanical, chemical, and dynamic.—*Transactions of the Medical Faculty of Maryland*, 1875.

EFFECTS OF CHOLERA ON THE MUCOUS MEMBRANE.

In a valuable report to the United States government upon the microscopic examination of the intestines in cases of cholera, Dr. Danforth says that not only are the mucous and muscular layers much disturbed and widely separated, showing between them a beautiful loosely woven web of areolar or connective tissue, but that not a single perfect villus can be seen; a few stumps only remain. The surface of the mucous layer is quite denuded, and the clothing of epithelium stripped from its surface. Peyer's glands are not much altered. It seems almost beyond belief that a few short hours can so totally change the intestinal surface.—*Monthly Microscopical Journal, March*, 1876.

THE BLOOD IN TYPHOID FEVER.

M. Comil has found, in the blood of the spleen of patients who have died in the third week of typhoid fever, large numbers of white globules, inclosing red globules to the number of five or six, or even more, in a single cell. Though this is nothing new, M. Comil is the first to insist upon their multiplication in typhoid fever.—*Monthly Microscopical Journal, May*, 1876.

ASIATIC CHOLERA.

Dr. Bonnafont, in a communication upon the Asiatic cholera read before the Academy of Medicine of Paris, ennunciates the following general propositions: First, this disease can not originate spontaneously in any other country than India, but must reach other regions by transportation, or by germs of the disease, atmospheric currents, or some other vehicle; second, all hygienic methods to avert this plague must be initiated and maintained in the country of its origin; third, that it is not the dead bodies of animals abandoned on the soil by caravans of pilgrims, nor the number of human bodies thrown into the Ganges, that produce the eruptions of the Asiatic cholera, as these practices have prevailed for ages, while appearances of epidemic or Asiatic cholera in Europe, Africa, or America date only from the beginning of the present century; fourth, other causes, therefore, must exist for the frequent movements of this disease, and it is in India that these are to be investigated; fifth, secondary epidemics may perhaps be developed in points already infected; but, with very rare exceptions, they never assume the exact features of genuine cholera, and they will generally fade out and disappear until reinforced by a new eruption from the original starting-point. Therefore the special points to be considered are the questions why cholera has remained for centuries in an endemic and stationary condition in India, and why it has recently emerged, though the atmospheric conditions, and the manners and customs of the Hindoos and pilgrims, apparently remain unchanged.—1 *B*, XV., 299.

PECULIAR DISEASE AMONG DOGS IN CHINA.

The dogs of China are subject to a curious infliction, known as "worms in the heart," the symptoms of which are the vomiting of blood, staggering, and death within twenty-four hours of the attack. In one instance, in dissection, a continuous rope of worms was found, fourteen inches long, stretching from the right hepatic vein through the cava into the right auricle, and thence, by a fine twist of one or two worms, through the tricuspid valve into the right ventricle, together with a rope of worms, fourteen inches long, stretching into both lungs. The precise species of entozoon has not been indicated, but it produces death very quickly, mostly in a mechanical way, by blocking up the bloodvessels and cavities of the heart. Treatment is difficult, as the disease is seldom recognized during life, and when death comes, it is so sudden as to give but little time for remedies. Even if the worms could be killed, they would probably be as injurious dead as alive, so far as choking up the heart goes. The problem is not yet solved as to the mode of their entrance into the circulation.—2 *A*, XIX., 357.

TREATMENT OF ASTHMA.

It is generally supposed that an antagonism exists between atrophia and morphine, by which the one neutralizes the other, and this may possibly be the case where either is administered separately, and is followed by the application of the other at some interval. According to Dr. Oliver, however, when the two are combined in the form of a hypodermic injection, some of the more uncomfortable effects are relieved in certain cases, if not entirely removed. This writer insists that the general result is a more rapid action, and almost entire absence of disturbance of the stomach in the production of nausea, so distressing to patients who have been treated hypodermically with morphine alone.

The treatment of the physician referred to is more particularly applied in cases of attack of spasmodic asthma. At first the injections were administered after the attack itself; subsequently, however, the friends of the patient were instructed in the use of the instrument, and used it immediately on the first indication of the trouble. This was continued for a period of three years, during which every one of the attacks, previously so distressing, was entirely prevented. The injections were made in the morning for several days in succession. The continued employment of these injections did not appear to be at all injurious to the general health. A prompt relief was usually produced in five minutes, resulting in a calm slumber. The most severe attack disappeared in from fifteen to twenty minutes. A similar good effect from the combination of the two substances has been found in the treatment of dyspnœa.—12 *B*, *February* 29, 1876, 184.

FRENCH INVESTIGATION OF HAY-FEVER.

The *Bulletin Scientifique*, of Paris, refers approvingly to the opinion expressed by M. Decaisne concerning hay-fever. He does not think the annual periodicity, which is usually given as one of the characteristics of the disease, to be well established, many persons being sometimes free for years in succession, and others experiencing several attacks at irregular intervals. The difficulty of breathing, which is sometimes considered an inseparable condition of hay-fever, is, according to this authority, simply the result of a more decided extension of the irritation which attacks the conjunctiva and the nasal and pharyngeal mucal surface. So far, too, from there being any greater tendency to the disease among hay-makers and farmers than any class of the community, the affection appears, in fact, to attack agriculturists and persons of other occupations indifferently—showing that the emanations from forage plants can have, at most, only a very secondary influence in the case. All the symptoms are exhibited at any season, as the result of sudden exposure to cold when the body is in a condition of perspiration, whether subjected or not to dust or other irritating emanations. The disease must be regarded, therefore, as simply a catarrhal fever, influenced and modified in its origin and progress according to individual peculiarities and by atmospheric conditions.

COCHIN-CHINA DIARRHŒA.

The Cochin-China diarrhœa annually carries off about 1000 men of the French army and navy. According to Dr. Normand, naval surgeon, this disease is produced by the presence in the intestines of an enormous number of intestinal worms, of the new species, *Anguillula stercoralis.* It is one fourth of a millimeter in length.—*Popular Science Monthly, November.*

INDIAN CORN AND ENDEMIC PELLAGRA.

In Southern Europe, and especially in Italy, in localities where maize is largely consumed by the poorer classes, pellagra has long been prevalent, and has been almost exclusively confined to such as subsist for the most part on corn meal. In Cremona one out of every twenty-four of the population is thus afflicted, and in Brescia one in forty-one, and the number is annually increasing. The mould *Sporisorium maidis,* detected on grains of corn in 1870 by Bellardini and Cassati, was suspected as the cause of the disease, as well as the common mould, *Penicillium glaucum,* so frequently found on improperly dried and imperfectly stored corn. According to the observations of Professor Lambrosa, however, there is no connection between those fungi and the pellagra, but the disease originates rather in the rancidity of the fatty oil, richly present in corn meal. He showed that the disease can not be excited either by introducing the above moulds into the stomach or directly into the circulation, but that it can be produced by the administration of corn meal that has become rancid. He contends, therefore, that the disease in Lombardy results in part from late planting, which prevents the ripening of the grain, and that planting too thickly, harvesting too early, drying the ears imperfectly, together with storage of the corn and meal in damp places, all contribute to render the disease epidemic. He attributes the total absence of the disease from portions of America where maize is almost exclusively used for food to the thorough ripening and drying of the grain, and the conversion of comparatively small portions into meal at a time. He recommends, therefore, the keeping on hand of but a limited supply of freshly ground meal, and the preparation of small cakes instead of the usual large loaves, which are seldom baked through, and which, as they are often kept fourteen days, are very liable to spoil. According to Professor Haberland, the disease has not yet been noticed in the southern portions of Austria, where corn is also largely consumed. He suggests that the rancidity may be prevented with certainty by removing the oleaginous germ before grinding.—1 *C*, 1875, 218.

IMPROVED DENTAL PROCESS.

Napier, the well-known English dentist, has devised what he considers a valuable process in dental surgery, especially in a case where the teeth are extremely sensitive, and it becomes necessary to file them down for the purpose of introducing artificial teeth on the stumps. For the sake of avoiding pain in the operation as far as possible, ether spray is first made use of in reducing the sensibility of the teeth—a piece of cotton dipped in ether and laid first on the teeth and then on the instrument being found to answer a still better purpose. While engaged in this operation, it occurred to Dr. Napier to avoid the usual practice of dentists of extirpating the nerve, with which object he took a bit of hard wood, dipping it in nitric acid, and with this cauterizing the exposed portion of the nerve in each tooth successively. He then filed the teeth down to the level of the gums without producing any pain whatever. He found that in this way the stump of the tooth remained perfectly healthy, giving no pain of any kind, and that the subsequent experiences of the patients were of the most satisfactory nature.

POISONOUS PROPERTIES OF GLYCERINE.

In a paper by Dujardin-Beaumetz upon the poisonous properties of glycerine, it is stated that this substance, chemically pure, when introduced under the skin of a dog, causes death in a dose of eight to ten grammes per kilogramme of the weight of the body, the general symptoms of the poison being those of alcoholism.—12 *A*, *July* 30, 65.

POISONOUS PROPERTIES OF FUCHSIN.

The question of the poisonous properties of fuchsin, now so extensively used as a dye, as also for coloring wines, has been a subject of much contention by chemists and toxicologists. It is now quite generally accepted that when chemically pure it is harmless, being dangerous only when containing foreign impurities. This conclusion has quite recently been reached by Poisson, who fed rabbits in successive doses with pills of this substance, chemically pure, without producing any apparent injury. On killing the rabbits the viscera were all brightly colored with violet red, but no inflammation or lesion was appreciable in any part.

REPORT OF MASSACHUSETTS STATE BOARD OF HEALTH.

An important addition has been made to the valuable documents published by the Massachusetts State Board of Health, in the form of a special report on the pollutions of certain rivers in the state, such as the Blackstone, Charles, Chicopee, and others, with general observations on water supplies and sewerage, as prepared by Mr. James P. Kirkwood. There is also an appendix, containing certain analyses by Professor Nichols; "The Drainage and Sewerage of the State from a Sanitary Point of View," by Dr. Winsor; and "The Disposal of Sewage," by Dr. Folsom. The report closes with series of summaries and recommendations.

From this report we learn that the most widespread evil in Massachusetts, as brought out by the investigations of the board, is the dampness of soil arising from incomplete drainage, or the lack of removal of the water.

The general question of the disposition of sewage is one that has occupied the attention of the board. A well-ordered water supply, water-closets, and suitable drainage in connection with a system of sewers is, of course, the best. The substitutes for water-closets are, first, frequent disinfection with dry earth, and prompt and frequent removal of all excrement; second, the disposition of slop-water in such a way that it can not putrefy and contaminate the air in the neighborhood of dwellings. This is well attained by a system of irrigation devised by Mr. Rogers Field, of London; but where this can not be adapted, it is said that the safest way is to dispose of slop-water on the surface of the ground not near dwellings, where the organic matters in suspension or solution will be taken up by vegetation. All tanks, reservoirs, cesspools, etc., may be always looked upon as likely to cause serious trouble under the immense majority of circumstances.

CINCINNATI HAMS.

The health authorities of Paris have lately prohibited the sale in that city of Cincinnati hams, which, as is well known, are generally put up in canvas, colored of a brownish hue. According to the results of a chemical investigation, this color is due to chrome-yellow, or the chromate of lead, which is in itself a highly poisonous substance.

Professor Bouchardat suggests, in a communication on the subject, that if a brown color for this purpose is desirable, there are numerous substances, such as curcuma and others, which are entirely inoffensive, and which would be equally valuable in producing the general effect of color.—12 *B*, *May* 15, 1876, 430.

EXCLUSION OF DUST FROM THE LUNGS.

Dr. B. W. Richardson, in a series of lectures upon unhealthy trades, recently delivered in London, mentions a new device for the filtration of dust, the injuries from which are known to be among the most serious to which mechanics and operatives are subjected. Whenever filings and fine dust of any kind are produced, it is very important to prevent the introduction of particles of the foreign substance into the lungs, as even an occasional exposure may do great harm, while one continued for many months or years almost inevitably produces fatal results.

Dr. Richardson states that the principal conditions in a mask, in order to secure perfection of action, are a free entrance of air and freedom of exit, with balance for respiration and expiration so arranged that the expiration should be at least one sixth freer than the inspiration; second, the removal of the water of expiration; third, selection of a material for filtration that shall absorb the smallest possible amount of water, offer as little resistance as is possible, and filter finely; fourth, arrangement of the filter so that it should, as far as possible, clear itself, in expiration, of the dust it had received during the time the air was being drawn through in the act of inspiration.

For these purposes numerous devices have been presented; among them one by which the air is passed through cotton. In this, however, the cotton soon becomes saturated with water; the breathing is difficult even in pure air. A second form, made of layers of crape spread over a light framework, is easily put on and off, and it admits the passage of the air in either direction freely, but it allows the water to accumulate in the meshes, and it filters badly. It answers fairly for very coarse dusts, but the finer sorts, such as flour, are not excluded.

Other very complicated forms were mentioned; but the one to which the lecturer referred as having all the good qualities and none of the disadvantages of the rest is made of feathers arranged around the outside of a perforated breathing tube of a convenient size, a line of feathers being fastened to the tube, and wrapped around it so closely as to cover all the perforations. By breathing through the upper end of this tube, the feathers come down to the perforations in inspiration, and expand in expiration so as to be lifted from the openings, and all the intercepted dust is blown off. Very little moisture is collected, and the apparatus is considered almost perfect.

The tube is fastened in a mask, which is tied around the feathers, so as the more readily to keep them in the proper position. It can be put on and taken off as easily as if it were a pair of spectacles. The filter-tube is placed below, so as to catch all the inspired air, and by means of the two side expiratory valves nearly all the moisture of the breath is set free.—18 *A, June* 9, 1876, 326.

ELECTRICAL ALARM AGAINST CARBONIC OXIDE.

The following is the general construction of a small apparatus, designed by Ansell, which is said to indicate the presence of a comparatively small amount of carbonic oxide in the atmosphere by starting an electrical alarm, and seems to be especially adapted to sleeping-chambers, where there may be any danger from the escape of gas. A pear-shaped vessel, closed at the top with a porous membrane—best with an unglazed earthen plate—is connected at the bottom with two communicating tubes filled to a certain height with mercury. The tube not immediately connected with the vessel ends in a small hollow glass bulb, containing a platinum wire reaching nearly to the mercury. The poles of a battery, including in its circuit an alarm-bell, are connected respectively with this wire and the mercury. In an atmosphere containing carbonic oxide, this gas, of lower specific gravity, will diffuse so much more rapidly through the porous membrane into the vessel filled with air, that sufficient pressure will be produced to cause a depression of the mercury in the tube connected with it, and a corresponding elevation of it in the other, until it comes in contact with the platinum wire, when the alarm will be sounded by the completion of the circuit.—18 *C, February* 9, 1876, 81.

O. NECROLOGY.

Angelin, Nils Peter. For many years Superintendent of the Paleontological Department of the Royal Museum at Stockholm, and author of numerous memoirs on the geology and paleontology of Sweden. Died February 13th, at the age of seventy.

Balard, M. Member of the Academy of Sciences of Paris, and Professor of Chemistry at the Sorbonne. Died in Paris, at the age of seventy-four.

Baudeira, Marquis Sa de. Author of several papers on the Portuguese possessions in Africa. Died at Lisbon, February 6th, at the age of eighty-one.

Becher, Rear-Admiral A. B. Entered the British navy in 1812, and became editor of the *Nautical Magazine*, after a period of service in surveying on the Canadian lakes, in the Hydrographic Office, and in the Admiralty. In 1856 published "The Landfall of Columbus," identifying Watling Island with Guanahani. Died February 14th, in the eighty-fourth year of his age.

Bird, Frederick. An astronomer; specially skilled in polishing mirrors of telescopes. Died at Birmingham, September 27th, aged sixty.

Bleek, Dr. W. H. D. Born in Berlin in 1827. Distinguished as a philologist, and an author of several works upon the languages of South Africa, Australia, and Polynesia. Died August 17th, at Capetown, in the fiftieth year of his age.

Boeck, Dr. William. Author of important works on elephantiasis and other diseases. Died at Christiania, December 10th.

Bollaert, William. An explorer in Central and South America; especially interested in geology and archæology. Died November 15th.

Borlan, Alexander. A local botanist of Angers, France.

Brongniart, Adolphe. An eminent French naturalist. Born January 11th, 1801. Author of many important botanical works, and one of the founders of the *Annales des Sciences Naturelles.* Died February 18th, at the age of seventy-five.

Buchholz, Dr. R. Well known in connection with polar exploration, and more recently with travels in Central Africa. Died April 17th.

Carrington, R. C. Known as the proprietor of Red Hill Observatory, and subsequently of the observatory at Churt, near Farnham, where he died, November 1st; author of a catalogue of circumpolar stars.

Chekanovsky, M. An exile to Siberia, he devoted many years to the study of the geology of that country, and made extensive collections on the shores of the Polar Sea. Died in October.

Cornelissen, Lieutenant J. E. Head of the marine branch of the Utrecht Institute. Died at Brussels in March.

Cresson, John C. Professor of Mechanics and Natural Philosophy in the Franklin Institute of Philadelphia, of which body he was president. At the time of his death, January 12th, aged seventy, was chief-engineer of the Philadelphia Park.

Davies, Professor Charles. A well-known author of mathematical text-books, a West Point graduate, and Professor of Mathematics in Columbia College from 1857 to 1867. Died on the 18th of September, in his seventy-ninth year.

Delvigne, Gustave. Inventor of an explosive bullet and rifled gun.

Desmoulins, Charles. President of the Linnæan Society of Bordeaux. Died December 23d, 1875.

D'Orbigny, Professor. An eminent French zoologist, and connected with the Paris Museum of Natural History.

Edwards, F. E. Author of several valuable monographs on various groups of eocene mollusca. Died in England, October 15th, at the age of seventy-six.

Ehrenberg, Professor C. G. Born in Prussian Saxony in April, 1795. An eminent microscopist, and author of several works on infusoria; making a specialty of the examination of deep-sea soundings, a great number of new species of these minute organisms having been described by him. Received many honors in the way of membership in learned societies; was Secretary of the Academy of Sciences of Berlin, a member of the Royal Society of London, and one of the eight foreign associates of the Academy of Sciences of Paris. Died June 27th, in the eighty-first year of his age.

Fearn, Thomas. An accomplished metallurgist of England. Died in September.

Forbes, David. Foreign Secretary of the Iron and Steel Institute. Died December 5th, at the age of forty-nine.

Fuckel, Leopold. Well known for his mycological writings, and his published collection of fungi, entitled "Fungi Rhenani." Died at Vienna, May 8th.

Gamond, Thomé. Born in Paris in 1798; educated in Holland; was the originator of the Channel Tunnel enterprise. Died in February, at the age of seventy-eight.

Grattoni, Signor Severino. An Italian engineer, and superintendent of the construction of the Mont Cenis Tunnel.

Gray, Mrs. Widow of the late John Edward Gray of the British Museum. Died at an advanced age.

Guichenot, Alphonse. Well known for his connection with the chair of herpetology and ichthyology in the Museum of Paris. An assistant on the systematic works upon the natural history of Chili, Cuba, and elsewhere, published under the direction of the French government. Died February 17th, aged sixty-seven.

Hearder, Dr. Jonathan. An inventor and manufacturer of many forms of electrical and chemical apparatus, an early advocate of a telegraphic cable across the Atlantic; also a manufacturer of fishing-tackle and other apparatus for the capture of fish, his trawl-nets having been used by the British *Challenger* expedition and the United States Fish Commission. Died at Plymouth, England, July 16th, at an advanced age.

Jacobi, Lieutenant-General. The monographer of the genus Agave. Died at Berlin.

James, Dr. Born in Richmond, Virginia. Surgeon and naturalist of the *Chevert*, a vessel fitted out by Mr. Maclay for exploration in New Guinea. An accomplished collector. Killed by the natives of Yule Island, New Guinea, September 15th.

Jelinek, Dr. Carl. A distinguished physicist, and publishing much relating to magnetism and meteorology. Director of the Central Institute for Magnetism and Meteorology at Vienna. Died at Vienna, October 9th, aged fifty-four.

King, Dr. Richard. A companion of Sir George Back in his arctic travels, of which he wrote a narrative; author of many articles of a medical and sanitary nature, and editor of a statistical and ethnological journal. Died February 4th.

Kopp, Professor E. An Alsatian by birth; a professor in the University of Strasburg previous to 1848; afterward Professor of Chemistry in the Polytechnic School of Zurich; well known as a writer on the history and progress of the coal-tar colors. Died November 3d, at the age of fifty-nine.

Kowalevsky, Dr. J. Secretary of the Caucasian section of the Imperial Russian Geographical Society, and editor of its publications.

Laplace, Admiral Cyrille. Well known as connected with numerous voyages of discovery, the results of which added much to the knowledge of physics and natural history of the globe. Died at Brest, January 24th.

Leigh, Evan. Inventor of the "twin screw," and other details connected with cotton machinery. Died at Manchester, England, February 2d, in the sixty-fifth year of his age.

Letheby, Dr. Distinguished as an analyst, and for many years medical officer of health in the city of London. Died in April, at the age of sixty.

Lucas, Louis A. A well-known African traveler. Died near Jeddah, on the Red Sea, in November.

Macaya, de Castera. Born in 1800. Well known as Secretary and President of the Geographical Society of Paris, and author of numerous essays upon geographical subjects. Died in Paris, January 14th, aged seventy-six.

March, William T. A resident of Jamaica, and specially interested in its birds and plants. Author of several papers on Jamaica birds. Died at an advanced age.

Marvine, A. R. Born 1848. United States government geologist and explorer. Died at Washington, March 2d.

Meek, Professor Fielding B. One of the most distinguished of American paleontologists. Died at the Smithsonian Institution, December 22d, aged fifty-nine.

Melville, Andrew Smith. Lecturer on botany and geology in the Edinburgh School of Arts. Died July 22d.

Miller, Mrs. Widow of the late Hugh Miller. Died at the age of sixty-four.

Minascalchi-Erizzi, Count. A founder of the Italian Geographical Society. Died December 30th, 1875.

Mohl, Professor Jules de. Professor of Persian in the College of France. Died at the age of seventy-six.

Munzinger, Werner. A Swiss by birth; an eminent explorer in Africa; author of several valuable works, and contributed largely to the journal of the Royal Geographical Society.

Napier, Robert. Born in 1791. An eminent citizen of Glasgow, distinguished among British engineers, and as the proprietor of the great establishment at Glasgow for the manufacture of marine engines, and as the builder of most of those of the Cunard steamers. Died June 22d, at the age of eighty-five.

New, Charles. A well-known missionary and traveler in East Africa. Author of various notes of travel. Born in 1840. Died at Durnma, February 14th.

Newman, Edward. An eminent naturalist, his labors having special reference to entomology and the ferns. Best known as the editor of the *Zoologist* and the *Entomologist*. At the time of his death in charge of the natural-history department of the London *Field*. Died at Peckham, England, June 12th, at the age of seventy-five.

Noltke, Ernst Ferdinand. A veteran botanist of Kiel. Died February 13th, at the age of eighty-four.

Parkes, Dr. A well-known army surgeon; author of many important papers of physiological and biological merit. Died in March, at the age of fifty-six.

Pertz, Chevalier. For many years librarian of the Royal Library of Berlin. Died in October.

Pfunds, Dr. Attached to Colonel Colston's expedition to Kordofan and Dar Fur. Died at the latter place, August 23d.

Pictet, Adolphe. An eminent writer on ethnology and comparative philology. Died at Geneva, in December, at the age of seventy-six.

Ponier, Porter. A most promising student of physical science. Died at Newark, New Jersey, June 11th, at the age of twenty-three.

Redmond, M. An English missionary traveler in Africa.

Redtenbacher, Dr. Ludwig. Director of the Imperial Zoological Museum of Austria. Author of numerous works on entomology, etc. Died at Vienna, February 8th, at the age of sixty-three.

Reuschle, Professor K. G. Author of many works on geography and physics. Died at Stuttgart, May 23d, at the age of sixty-five.

Rizaux, Professor. Radcliffe astronomical observer at Oxford.

Rousseau, Henry. One of the founders of the Troy Lyceum of Natural History. Died in that city, September 19th, at the age of seventy-five.

Russell, Alexander. Author of a standard work on the salmon. Died in Glasgow.

Scrope, George Poulett. Born in London in 1797. An eminent geologist, his specialty being the investigation of recent and extinct volcanoes and the phenomena of igneous rocks generally. Author of many important works relating to these subjects.

Séna, Baron von. Known as connected for many years with the observatory at Athens, which was founded by his father. Died at Vienna, April 15th, in the sixty-fifth year of his age.

Simon, Dr. Professor of Surgery in the University of Heidelberg for fifty-three years. Died recently in that city.

Simskowski, George F. Best known from his report of travels of the Russian mission through Mongolia to China. Died in the spring of 1875, at the age of eighty-five.

Smith, George. Connected with the British Museum. Distinguished in the department of Assyrian antiquities and history. Died at Aleppo on the 19th of August.

Snell, Professor Ebenezer S. Professor of Mathematics in Amherst College, Massachusetts. Died September 18th, at the age of seventy-five.

Transon, Abel. An eminent mathematician and professor in the Polytechnic School at Paris. Died in that city in August, at the age of seventy.

Van Houtte, Louis. An eminent Belgian horticulturist, distinguished for his scientific knowledge of plants and his numerous experiments in regard to their growth. Died May 9th, at the age of sixty-six.

Vignoles, Charles B. A well-known English railway engineer. Died in November, at the age of eighty-two.

Von Baer. An eminent Russian naturalist.

Von Heuglin, Theodor. A distinguished African explorer and collector; a specialist in ornithology. Died at Stuttgart, at the age of fifty-two.

Von Waltershausen, Dr. Professor of Mineralogy at Göttingen, where he died, October 16th, aged sixty-seven. Specially interested in researches upon volcanoes.

Von Willemoes-Suhm, Dr. R. Born September 11th, 1847. One of the zoologists of the *Challenger* expedition. Died on board that vessel between the Sandwich Islands and Tahiti, September 13th, at the age of thirty.

Wing, Rev. Augustus. Especially interested in the investigation of the rocks of Vermont, particularly the crystalline limestone, quartzite, and slates of the central portion of the state; discoverer of Lower Silurian fossils in the crystalline limestone. Died at Rochester, Vermont, January 19th, at the age of sixty-seven.

Wright, Dr. Thomas S. A practicing physician, who found time for investigations in British marine zoology. Died in Edinburgh, in October, aged fifty-eight.

Wyndham, T. Heathcote G. A chemical mineralogist. Died in November.

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The following list of books relating to the several departments of science contains only a small portion of those published during the past year, but, it is believed, embraces the most important. The limitations of the *Record* preclude an exhaustive bibliographical enumeration or plan; nor, indeed, is this required by readers. Works only have been introduced that have features of general interest to commend them, especially such as have been more or less favorably noticed in the principal journals devoted to general science, and mention will be found of the places in the several journals where criticisms are contained. These references will serve in lieu of the critical notices which were proposed in a previous volume for the present *Record;* experience having shown that, in order to do justice to the several works and to ourselves, more space would be required than could be well spared for the purpose.

Whenever the volumes themselves were accessible, the titles and collations have been taken directly from them. In many cases, however, the compiler has been obliged to depend solely on the titles contained in the journals in which the volumes have been noticed, or upon booksellers' announcements. These are often, and indeed generally, deficient in some point or other: *e.g.*, the title may be imperfect or altered; the date of publication may be omitted, and then it can not be certain whether the volume has been published during the current year or in a past one; there is a difference in the statements as to sizes; the collation is frequently absent or erroneous, and the number of pages incorrectly given, and sometimes even the place of publication is omitted. Wherever the means of verification or correction by referring to the volumes themselves have been possible, they have been improved; unfortunately, however, in most cases the volumes themselves could not be consulted; the purchases for the public libraries of Washington are generally very dilatory, and works may have been published for many months, and even years, before they are procured. The compiler therefore is obliged to ask the indulgence of readers for any shortcomings in the enumerations of the volumes recorded.

All the scientific works sent to the editor of the *Record* have been, and will hereafter be enumerated, whether specially noticed in the journals in question or not. The responses to the invitation for the transmission of copies to the editor for notice have been numerous, but many important publications have been withheld. In the interest of accuracy and completeness of enumeration, the editor renews his request for copies of new works for notice in future numbers of the *Record's* Bibliography.

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(3.) Nature: a Weekly Illustrated Journal of Science. London.

(4.) The Popular Science Monthly. Conducted by E. L. Youmans. (Published monthly, at $5 per annum.)

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Q. INDEX TO THE REFERENCES.

In the large number of serial works received regularly for use in the preparation of material for the *Record*, it has been found expedient to adopt some mode of abbreviating the titles, so as to save both time and space in writing and printing them. For this purpose the different countries have been represented by letters, and the journals numbered as in the following table. Publications referred to only occasionally are indicated by abbreviations of their titles at the ends of the articles. Where no references are made, it is to be understood that the article is partially or entirely original, and prepared by the editor or his collaborators; in some cases, however, that the quotation has been mislaid or overlooked.

The list of works here mentioned relates simply to those most frequently consulted—especially those coming direct through the post-office—and forms but a small portion of those passed regularly in review. The unrivaled scientific library of the Smithsonian Institution is in regular and constant receipt of the latest publications from at least one thousand societies and establishments, public and private, in different parts of the world, all of which are used to a greater or less extent by the editor and his associates in the preparation of the *Annual Record.*

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3. Iron: the Journal of Science, Metals, and Manufactures: with which is incorporated the Mechanics' Magazine, established 1823. Weekly. London.
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5. The Popular Science Review. Quarterly. London.
6. The Geographical Magazine. Monthly. London.
7. London, Edinburgh, and Dublin Philosophical Magazine. Monthly. London.
8. Scientific Review: Record of Progress in Arts, Industry, and Manufactures; and Journal of the Inventors' Institute. Monthly. London.

10. The Annals and Magazine of Natural History. Monthly. London.

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12. Nature: a weekly illustrated Journal of Science. London.

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